USER MANUAL

MODEL 876-25

TOTAL FREE CHLORINE & pH ANALYZER

um-876-211

IC CONTROLS

Contents

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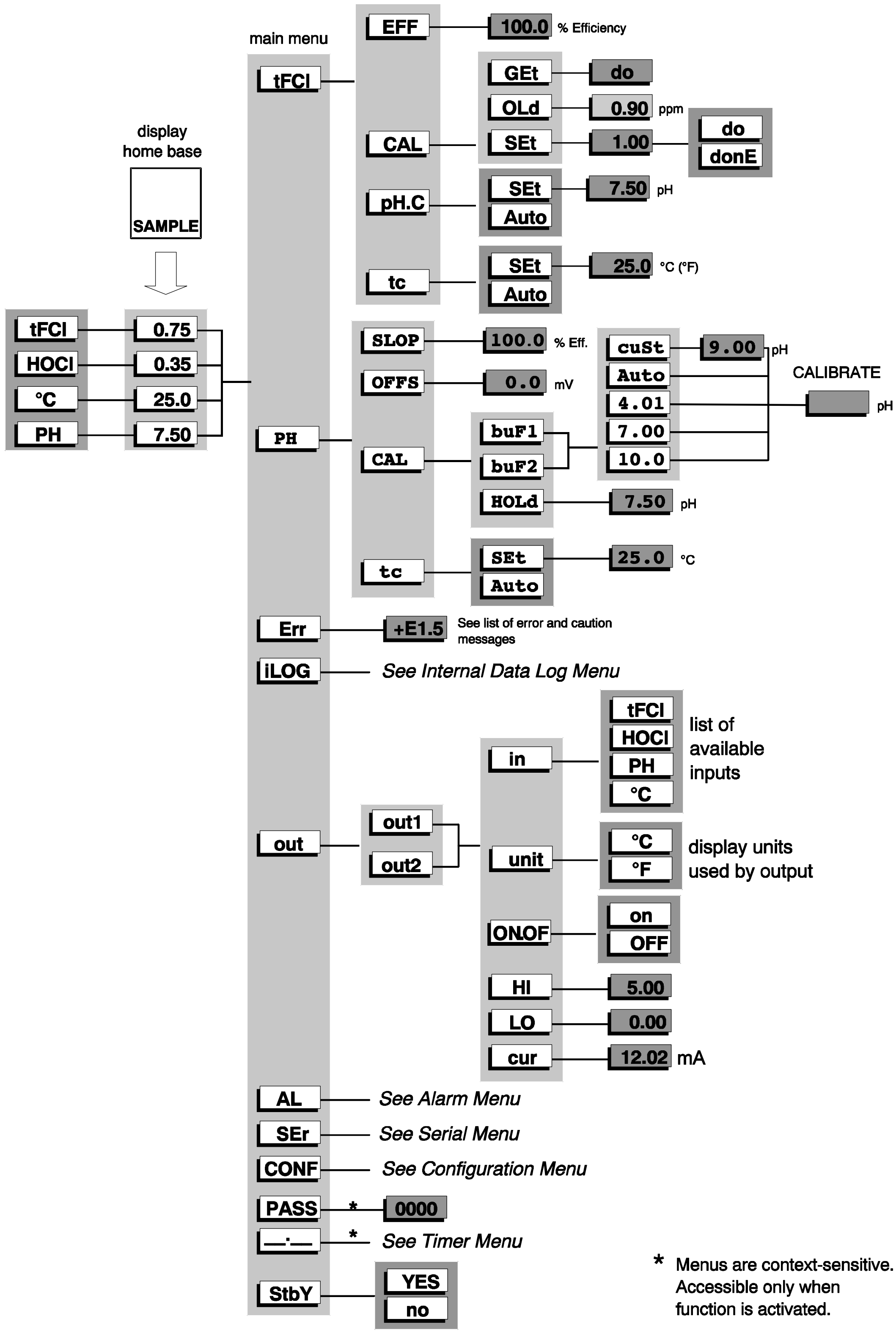


Illustration 1: Menu overview

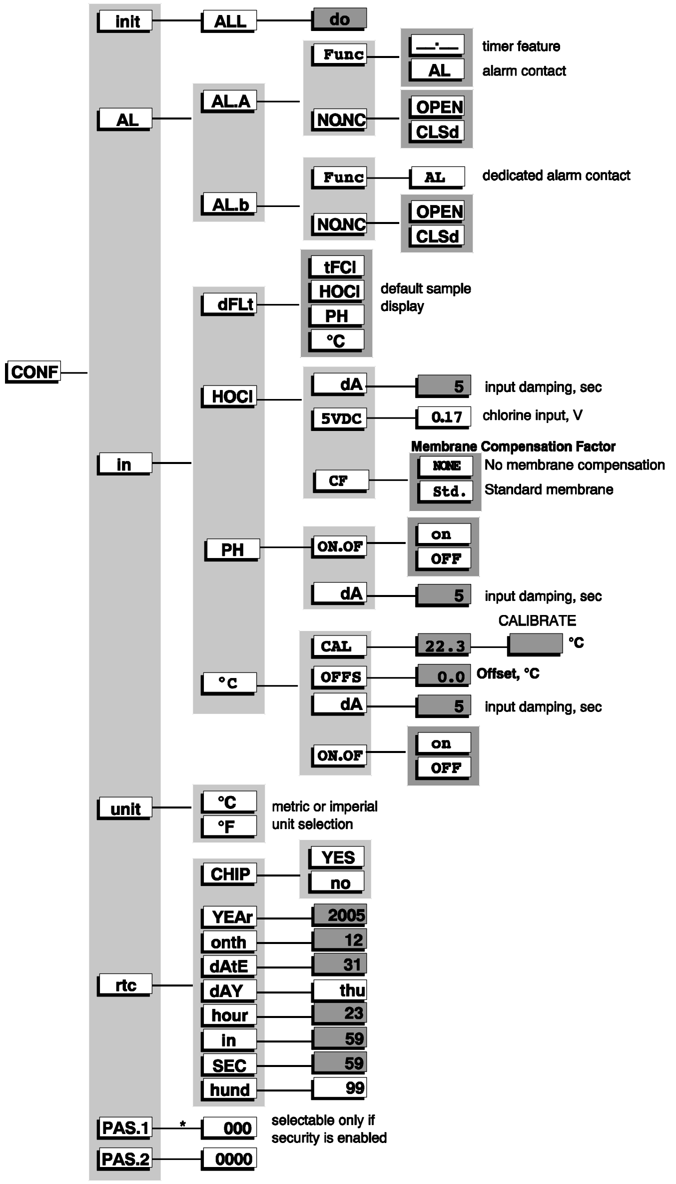


Illustration 2: Configuration menu

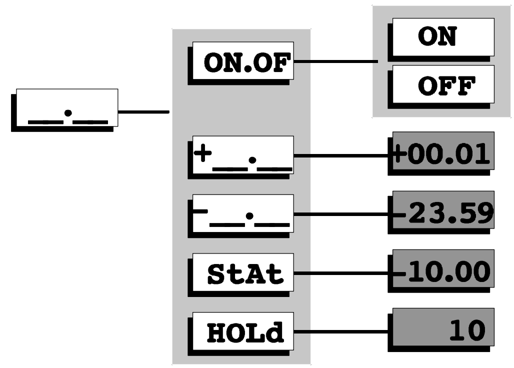


Illustration 3: Timer menu

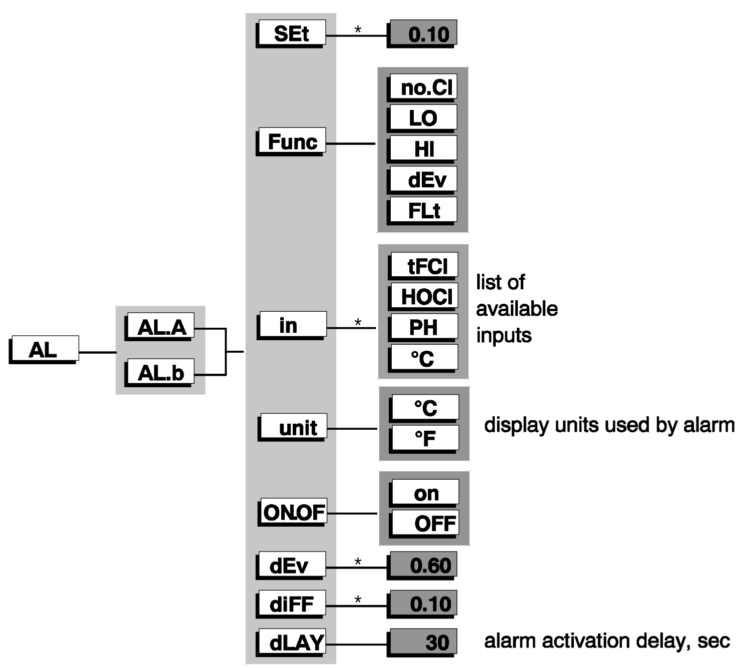
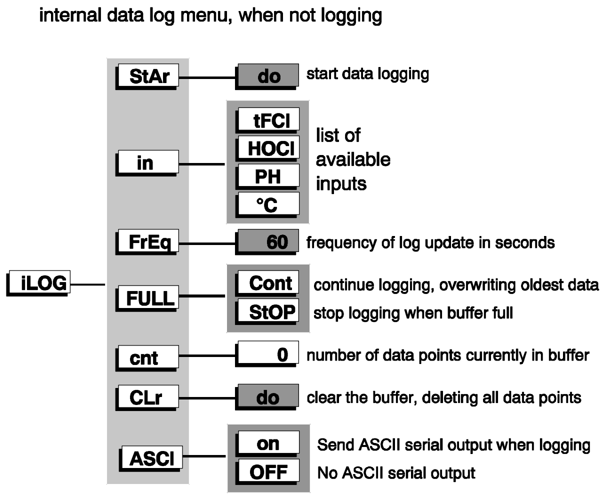


Illustration 4: Alarm menu



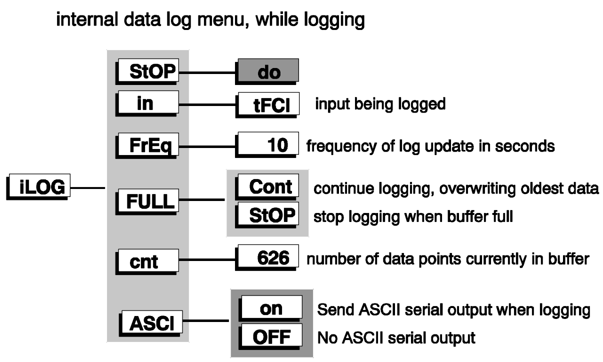


Illustration 5: Internal data log menu

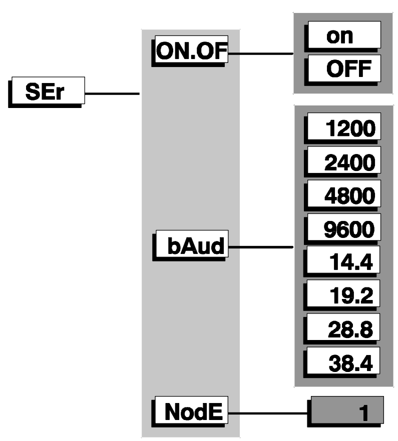


Illustration 6: Serial menu

INTRODUCTION

The model 876-25 is IC CONTROLS industrial quality remote operational total free chlorine and pH analyzer, designed to provide maximum flexibility, reliability, and ease-of-use. The model 876-25 analyzer has been designed to include a pH input to measure sample pH for continual pH compensation – ideal for samples with fluctuating pH values. Temperature compensation is obtained via a temperature sensor in the chlorine sensor.

The chlorine sensor used with the 876-25 is a galvanic cell that is separated from the process by a chlorine permeable membrane. As the hypochlorous acid (HOCl) in the process diffuses through the membrane, a galvanic reaction occurs which produces a current that is proportional to the free available chlorine concentration. An advantage of the galvanic cell is that an absolute zero measurement can be obtained; no chlorine present equals no chlorine produced. Many manufacturers use amperometric technology as opposed to galvanic. Amperometric cells rely on an induced voltage to produce a current. Since this residual current is always present, an absolute measurement cannot be obtained and the HOCl concentration measured may be artificially high. Another disadvantage of the amperometric method, that does not affect galvanic measurement, pertains to iron coating. Polarization attracts iron ions that may be in the process water which can cause coating of the membrane; iron deposits on the membrane can skew the chlorine readings.

General

The 876-25 is one of a series of 115/230 VAC process analyzers supplied in a corrosion resistant IP65 (NEMA 4X) watertight dustite case. These analyzers are also available for pH, ORP, dissolved oxygen, and conductivity, and are also available in two-wire versions with an optional explosion proof rating. In the case of CHLORINE, the analyzer measures the sensor signal corresponding to the actual chlorine with respect to the sample pH and temperature. The analyzer digitizes the signal for maximum accuracy, conditions it and then sends it out as a digital output and/or on 4 mA to 20 mA outputs.

The model 876-25 comes as a complete sample conditioning system. The analyzer is mounted on a CPVC panel with a dual flow cell containing the pH and chlorine sensors. The sample conditioning system includes a pressure regulator valve, head tank, sample point and atmospheric drain. The only installation requirement of the user is to mount the panel and supply plumbing to the inlet and from the outlet. A chlorine and pH calibration kit are supplied with the unit.

Features

The model 876-25 total free chlorine and pH analyzer has the following features:

- No reagents required: reagent based analysis typically require a separate waste outlet. Added reagents also require time for reaction, therefore, there is usually a lag time in response. No reagents allow for reduced stock and maintenance costs.
- No mechanical parts: since direct measurement does not require reagents to be added and sample mixing, there is no need for additional pumps, tubing etc., which also reduces the maintenance required.
- Immediate response without lag time: the direct measurement method used with the model 876-25 gives instantaneous results. By comparison, systems that use reagents require time for the sample to react with the reagent in the sample chamber, thus introducing a lag time.
- Galvanic technology: for better calibration with absolute zero. Galvanic technology does not attract iron to the sensor tip, therefore, the sensor requires less cleaning and maintenance.
- Automatic chemical cleaning option available.
- Easy to replace membrane.
- pH measurement and compensation for better accuracy.
- Intuitive user-friendly program that is easy to use.
- Grab sample calibration for chlorine.
- Self and sensor diagnostics.
- Two programmable 4 mA to 20 mA outputs.
- Two programmable alarms.
- Serial digital output and remote operation.
- Three level security to protect settings.

Specifications

Analyzer; 876

Physical Data	
PROPERTY	***CHARACTERISTIC***
Display	Four LCD digits, 1.5 cm (0.6 in) displays for total free available chlorine (tFCl) and free available chlorine (HOCl), pH, temperature, efficiency, error codes, prompts and diagnostic information (*back-lit display optional*).
Display Ranges	Total free available chlorine (tFCl): 0.00 mg/L to 5.00 mg/L Free available chlorine (HOCl): 0.00 mg/L to 2.00 mg/L pH: 0 pH to 14 pH units Temperature: -5.0 °C to 105 °C (23.0 °F to 221 °F)
Keypad	8 pushbutton entry keys
LED's	2 alarms (A and B), 1 auto, 1 error
Analyzer Dimensions	12.0 cm (H) × 20.0 cm (W) × 7.5 cm (D) [4.7 in (H) × 7.9 in (W) × 3.0 in (D)]
Panel Dimensions	36 cm (W) × 66 cm (H) [14 in (W) × 26 in (H)]
Weight	9.1 kg (20.0 lb)
Shipping Weight	11.4 kg (25.0 lb)
Shipping Dimensions	71 cm × 41 cm × 20 cm (28 in × 16 in × 8 in)
Environmental Data	
PROPERTY	***CHARACTERISTIC***
Temperature	Operational: 5.0 °C to 45 °C (41.0 °F to 113 °F) Storage: -10.0 °C to 55 °C (14.0 °F to 131 °F) Relative Humidity: 95 % maximum; non-condensing
Environment Ratings	Housing: IP65 (Nema 4X) Pollution Degree: 2 Installation Category: II
Electrical Ratings	115/230 VAC, 0.25 A, 50/60 Hz
Electrical Requirements	115/230 VAC ± 10 %, 50 W

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Specifications

Analyzer; 876

Operational Data	
PROPERTY	***CHARACTERISTIC***
Accuracy	Chlorine: ± 0.02 mg/L pH: ± 0.04 pH units Temperature: ± 0.1 °C
Precision	Chlorine: ± 0.01 mg/L pH: ± 0.02 pH units Temperature: ± 0.1 °C
Response Time	90 % within 5 s (default), function of flow and temperature. Damping adjustment: 3 s to 99 s
Temperature Compensation	Automatic temperature compensation via 1000 Ω Pt RTD. Auto: -5.0 °C to 105 °C (23.0 °F to 221 °F) Manual: -5.0 °C to 105 °C (23.0 °F to 221 °F)
Sample Conditions	Flow: 50 mL/min to 500 mL/min Temperature: 2 °C to 45 °C (35.0 °F to 113 °F) Pressure: < 400 kPa (60 psi, 4 bar) Drain: Atmospheric
Sample Inlet	1/2 in barb fitting
Sample Outlet	1/2 in barb fitting
Security	3 access-level security; partial and/or all settings may be protected via 3 and/or 4 digit security code.
Alarms	Two independent, assignable, programmable, configurable, failsafe NO/NC alarm relays; SPDT, Form C, rated 10 A 115 V/5 A 230 V.
Outputs	Two continuous, assignable, programmable 4 mA to 20 mA, or 0 mA to 20 mA outputs; isolated, max. load 600 Ω; Convertible from 1 VDC to 5 VDC or 0 VDC to 5 VDC.
Communication	Via RS485 bidirectional serial data port; require IC Net™ 2000 software.

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Specifications

pH Sensor; A2104033

Measurement Range..........0 pH to 14 pH units

Minimum Temperature..........0 °C (32 °F)
Maximum Temperature..........100 °C (212 °F)

Maximum Pressure..........689 kPa (100 psi)

Minimum Flow Velocity..........15 cm/s (0.5 ft/s)

Wetted Materials..........CPVC, PTFE, Viton, Glass

Electrode Dimensions
Diameter..........2.3 cm (0.9 in)
Length..........16.5 cm (6.5 in)

Process Connection..........fixed in the flow cell via a 1 in MNPT CPVC quick connect insertion fitting

Sensor Cable..........2 conductor; 1.5 m (5 ft) in length with BNC connector

Preamplifier..........Remote

Weight..........0.5 kg (1.1 lb)

Shipping Weight..........0.9 kg (2.0 lb)

Shipping Dimensions..........30 cm × 23 cm × 23 cm (12 in × 9 in × 9 in)

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Specifications

Chlorine Sensor; A2104034

Measurement Range
Free Available Chlorine (HOCl)....................0.00 mg/L to 2.00 mg/L
Total Free Available Chlorine ($HOCl + OCl^-$)....................0.00 mg/L to 5.00 mg/L

Minimum Temperature....................0 °C (32 °F)
Maximum Temperature....................80 °C (176 °F)

Maximum Pressure....................621 kPa (90 psi)

Principle of Operation....................Galvanic

Electrode Materials
Cathode....................Gold
Anode....................Silver

Minimum Flow Velocity....................15 cm/s (0.5 ft/s)

Wetted Materials....................CPVC, PTFE, Viton

Electrode Dimensions
Diameter....................2.3 cm (0.9 in)
Length....................16.5 cm (6.5 in)

Process Connection....................fixed in the flow cell via a 1 in MNPT CPVC quick connect insertion fitting

Sensor Cable....................4 conductor; 1.5 m (5 ft) in length with 5-pin DIN connector

Weight....................0.5 kg (1.1 lb)

Shipping Weight....................0.9 kg (2.0 lb)

Shipping Dimensions....................30 cm × 23 cm × 23 cm (12 in × 9 in × 9 in)

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INSTALLATION

Analyzer Mounting

The model 876-25 comes as a complete sample conditioning system. The analyzer is mounted on a CPVC panel with a dual flow cell containing the pH and chlorine sensors. The sample conditioning system includes a pressure regulator valve, sample point and atmospheric drain. The only installation requirement of the user is to mount the panel and supply plumbing to the inlet and from the outlet.

The panel mounts on a wall via four ⅜ inch bolts at 12¼ inch x 24¼ inch centers; refer to drawing D4040081 for mounting dimensions. Sample inlet and outlet plumbing hookup is via a ½ in barb fitting.

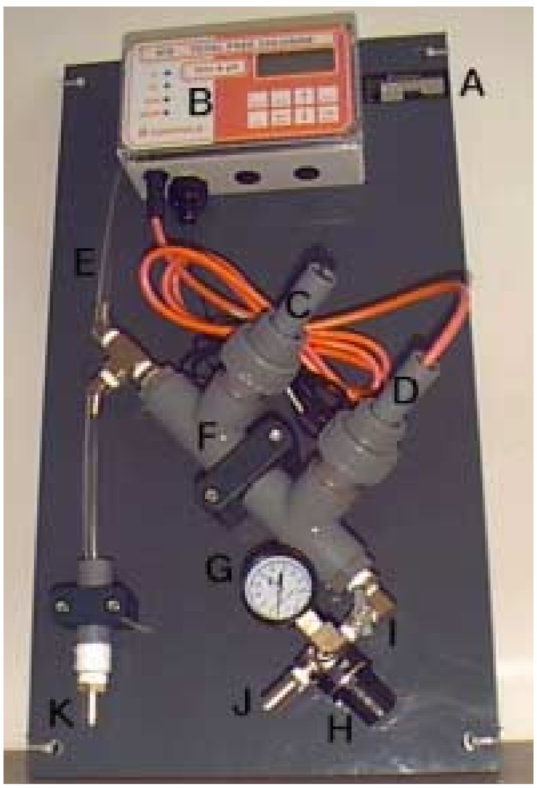


Illustration 7: 876-25 component identification

876-25 Component Identification

A) Identification label; indicates complete model number and serial number

B) Analyzer, model 876

C) pH sensor, P/N A2104033

D) Chlorine sensor, P/N A2104034

E) Atmospheric drain

F) Flow cell; a cleaning injection port is located on the underside of the chlorine sensor flow cell housing (hidden from view by the pressure guage)

G) Pressure guage

H) Pressure regulator

I) Flow control/shut-off valve

J) Inlet

K) Outlet

Analyzer Wiring

Please refer to drawing D5040276 and perform the following:

1. The 876-25 requires 115 V or 230 VAC power to be hooked up to TB400. Power consumed is less than 1 A so generally 16 guage wire is OK (consult local electrical codes for verification). For stable operation, the microprocessor needs a good earth ground.
   CAUTION: *Confirm that the 115/230 VAC switch is correctly set for your feed*.
2. If required, connect the two relay contacts; as supplied, they are not powered. They are typically used as L1 (HOT) circuit ON-OFF switches, in NO (normally open) configuration to control the chlorine or acid (pump/valve). Best practice uses a separate circuit to isolate the sensitive sensing circuits from any pump or solenoid inductive surges however, as a convenience for light loads, a 3 A circuit fuse (P/N A9160035) can be installed at F402 to feed the 876 L1 HOT to COM on relay A.
   Alarm A contact TB300, closest to AC lines.
   Alarm B contact TB301.
3. If required, connect the two isolated 4 mA to 20 mA outputs, these are 24 VDC.
   Output 1, TB303, closest to the relays.
   Output 2, TB304.
4. Connect the inputs.
   Chlorine sensor is direct connected to the analyzer via a 5-pin DIN connector.
   pH sensor is direct connected to the analyzer via a BNC connector.

Sensor Mounting

Optimum sensor performance with minimum user effort is provided through the use of the factory integrated sample system; 35.5 cm x 66.0 cm (14 in x 26 in) CPVC sample panel with pressure regulating valve, flow setting valve, atmospheric break, grab sample point, drain, plus dual flow cell housing the chlorine and pH sensors. The chlorine sensor and pH sensor are fixed in the flow cell via a 1 in MNPT CPVC quick connect insertion fitting.

The sensors are mounted within the sensor lead length, as near as possible to the chlorine analyzer. The flow cell is arranged so that the sensors are mounted on a 45 degree rising line, with the sensor's tip down at an angle anywhere from 15 degrees above horizontal to 15 degrees vertical. 45 degrees above horizontal is best because air bubbles will rise to the top and grit will sink, both bypassing the sensor. The pressure regulating valve installed before the flow cell functions to control and stabilize flow. The atmospheric drain allows for the collection of representative samples without disturbing sample conditions and acts as a vent for bubbles. The drain line should be larger than the sample line to allow for purging of sediments, bubbles, biologicals and other debris.

Sensor Wiring

The basic wiring scheme for IC CONTROLS chlorine sensor and pH sensor is shown in drawing D5040276. This wiring scheme is intended for cable lengths less than 20 meters (65 feet) where electrical interference is low. The chlorine sensor has a 5-pin DIN connector and the pH sensor has a BNC connector. This allows the sensors to be connected and disconnected easily at the analyzer.

Take care to route all signal wiring away from AC power lines, to minimize unwanted electrical interference. Avoid twisting the sensor lead, to minimize possibilities for broken wire. Make sure that the sensor connections are clean and tight.

Instrument Shop Test Startup

1. Apply 115/230 VAC power to the analyzer.
2. Hook up the chlorine sensor to bottom of analyzer via 5-pin DIN connector. Ensure that the shorting strap on the sensor connector is removed (refer to illustration 8). Keep shorting jack for future use.
3. With the chlorine sensor in air, the 876 analyzer should come up reading 0.0 ppm ± 0.05 ppm.
4. Run an "air" zero check; use wires to be field installed and allow 30 minutes warm-up time for the electronics to stabilize.
5. Run a "span" check. In the [tFCl] menu, change to these settings: [tc] [SEt] [25.0] and [pH.C] [SEt] [7.50]. A fairly accurate 1 ppm chlorine standard can be made from commercially available bleach; use a fresh 5.25% solution.

   a. Pipet 0.1 mL of bleach into a 1.0 L volumetric flask.
   b. Fill to mark with demineralized water. This will produce a 5 ppm standardizing solution.
   c. Pipet 20 mL of the 5 ppm solution into a 100 mL volumetric flask.
   d. Fill to mark with demineralized water. This solution should be used immediately after prepared and then discarded after 2 hours.
   e. Fill a plastic beaker with the 1 ppm chlorine standard and place the chlorine sensor into the beaker and stir.
   f. Wait 10 minutes; the 876 should read 1.0 ppm ± 0.3 ppm.

   Return the [tc] and [pH.C] settings back to [Auto].
6. To check for general performance, place the chlorine sensor in running tap water (chlorinated tap water should be between 0.2 ppm and 1.0 ppm). The display should read in that range.
7. Hook up the pH sensor via the BNC connector on the underside of the 876 analyzer and remove orange protective cap from sensor tip. Keep the cap for future use.
8. With the pH sensor in pH 7 buffer, the pH analyzer should display a reading of 7.0 ± 0.5 pH.
9. Run a "zero" calibration; 7 pH is equivalent to 0.0 mV so use pH 7 buffer.
10. Run a "span" calibration by placing the sensor in pH 4 buffer. The display should read approximately 4.01 ± 0.05 pH.
11. To check for general performance, place the pH sensor in pH 7 buffer again. It should now read approximately 7.0 ± 0.05 pH.
12. The sensor is now ready for field installation.
13. If the application will be in the caustic region, repeat steps 10 & 11 using pH 10 buffer so that the sensor is tested in the region of use.
14. Before placing the 876 analyzer into operation, verify the settings to ensure that they agree with the intended setup. Factory defaults are listed in *Appendix B*. For the 4 mA to 20 mA output, set high limit and low limit.
15. Set preference for temperature units, ° C or ° F in [CONF] [unit]; default is ° C.
16. Set desired input signal damping, if known; default is 5 seconds.
17. The analyzer is now ready for field installation.

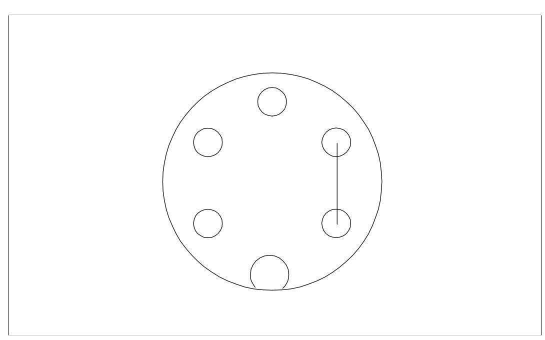


Illustration 8: Pin location for chlorine sensor shorting jack

STARTUP

If the analyzer is new and has not been installed, follow the procedures described in *Installation* and *Configuration of Program* before mounting. Mounting and wiring procedures for new installations vary with equipment options — see drawing section for instructions. If the analyzer has been previously installed, all that is required is to attach the electrode to the analyzer and then to turn on the power.

The analyzer will go through its automatic startup procedure any time power to the analyzer was lost for more than a few seconds. The startup procedure initializes the analyzer program, performs error checking, and then proceeds to display the chlorine and operate the analyzer normally.

All program settings, calibration settings, and defaults will have been remembered by the analyzer, as the memory is none volatile.

Analyzer Startup Tests

The startup procedure will begin by alternately flashing [tESt] and [——] and blinking the top LED while performing the memory tests. The analyzer will then display in sequence the analyzer number, in this case [876], any software option numbers, and the program version number, eg.[2.10]. The program then proceeds to the display test which will light each of the implemented display segments in turn. At the same time each of the LEDs will be lighted. If the analyzer passes all the tests, then the hardware is functioning properly and the analyzer will proceed to display total free chlorine.

If the analyzer displays +Err or -Err, this indicates that the input is off-scale. The error LED will be lighted as long as any input is off-scale. An off-scale error can indicate that the electrode is not in solution, is off-scale, or is not connected properly. If the error LED remains lighted, go to the error display section (select [Err] from main menu) to see what errors have been detected by the analyzer.

Calibration Settings Retained

If the analyzer was calibrated previously then the analyzer will use the calibration settings from the last successful calibration, otherwise default settings are used. Error and caution messages generated during the last calibration will remain in effect. IC CONTROLS recommends a full chemical calibration of chlorine after initial startup. Refer to the *Chlorine Calibration* section.

Analyzer settings and parameters can be viewed and/or changed at any time. Refer to the menus on pages 3 to 5; the areas shaded in dark gray indicate program settings.

Easy to use Menu

The layout of the program is shown in the menus starting on page 3.

Remembers Where You Were

The analyzer remembers where SAMPLE is. The sample display is home base for the program. The program also remembers which menu selections were used last and loops around the columns. The menu can be accessed using the arrow keys to find any parameter then press *SAMPLE* to return to the displayed reading. Then, using the *Right* arrow key return to exactly where you were.

Home Base: Press Sample

From anywhere in the menu, the *SAMPLE* key can be used to return to displaying tFCl. The program will safely abort whatever it was doing at the time and return to displaying the tFCl reading.

The tFCl display is the default sample display for the analyzer. The analyzer's inputs, tFCl, HOCl, pH and temperature, are arranged underneath each other at the left-hand side of the menu. Use the *Up* or *Down* arrow key to display each of the readings in turn.

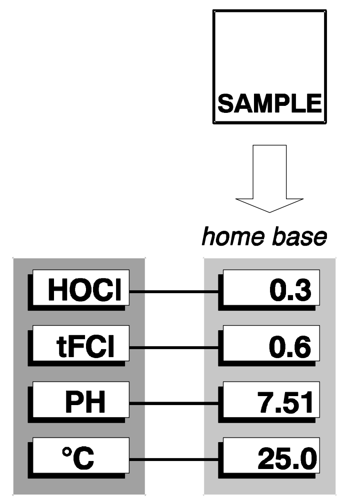


Illustration 9: Home base

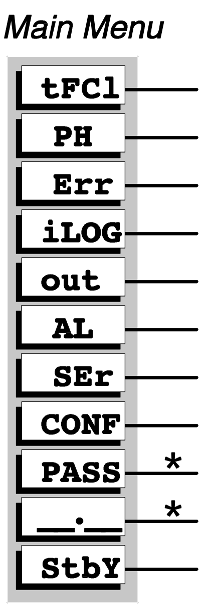


Illustration 10: Main menu

Display Features

1. The analyzer has a built-in timer which returns the program to displaying tFCl if no key is pressed for 15 minutes. This time-out has the same effect as pressing the *SAMPLE* key. If security has been enabled, then the time-out will change the access level back to 0 or 1 automatically which gives the user read-only access. The user will have to enter an appropriate password to go to a higher access level.
2. When the sample value is displayed, pressing the *Left* arrow key will show which of tFCL, HOCl, pH or temperature is displayed. Pressing *Right* arrow key displays the sample reading again.
3. The main sample, ie. the input that is displayed first when the *SAMPLE* key is pressed, can be changed. By default the main input is [tFCl]. Change the default in [CONF] [in] [dFLt]. Refer to the *Configuration of Program* section for further details.

Arrow Keys

The four arrow keys on the keypad are used to move around in the menu.

Example:
Press *SAMPLE* to make sure that display is at home base. Press the *Right* arrow key. One of the prompts in the column starting with [out] will be displayed. Use the *Up* or *Down* arrow keys to display the prompt above or below. If the prompt at the top or the bottom is displayed, the program will loop around. Press the *Up* or *Down* key until [AL] is displayed. Press the *Left* key to return to the sample display. Press the *Right* key again and [AL] will be displayed.

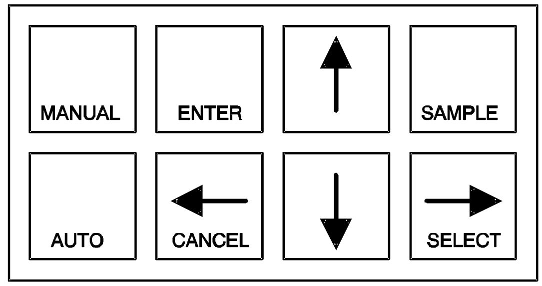


Illustration 11: Analyzer keypad

AUTO and MANUAL Keys

The AUTO and MANUAL keys are used to implement the alarm override feature. Refer to the heading *Manual Alarm Override* in the *Alarm Functions* section.

Standby Mode

Standby mode can be selected from the main menu. In standby mode the alarms will not function and the 4 mA to 20 mA outputs will go to 4.00 mA. When *SAMPLE* is pressed, all the inputs will show [StbY] instead of the normal input measurement.

The analyzer will not resume normal operation until the analyzer is taken out of standby mode. While in standby mode, the entire menu and all of the settings are accessible to the operator as before. None of the settings will take effect until the analyzer is returned to normal operation.

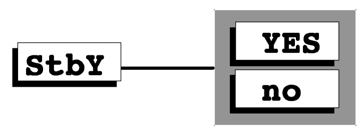


Illustration 12: Standby menu

The standby feature is protected by security level 2.

Output Hold

The 876 features an automatic output hold for the pH input only. Output hold goes into effect as soon as *SELECT* is pressed when [CAL] is displayed. The output hold feature avoids false alarms and erratic signal output that would be caused by a routine calibration. Output hold is not necessary for the chlorine input as chlorine calibration is performed by grab sample calibration only.

Output hold for the pH input has the following effect:

- 4 mA to 20 mA output signal for pH is frozen at it's current level
- alarms for pH are temporarily disabled

If the output signal for pH is not acceptable at the value found, it can be changed for the duration of the calibration. Select [Hold] from the pH menu to display the pH value used by the analyzer to determine the output signal. Use the normal editing procedure to change the pH value used for output hold.

The output hold remains in effect for the duration of the calibration, that is, the output hold is disabled when the [CAL] prompt is displayed, the *SAMPLE* key is pressed, or after no key has been pressed for 15 minutes.

Edit Mode

Edit mode is used to change a numeric value or to select between different options. Values and settings which can be edited are identified by the darker shading in the menu. Any frame which has a white background cannot be modified.

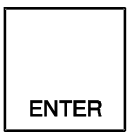
Editing by Selecting a Setting

Editing a value is like picking an option from a list; only one item on the list can be seen at a time. To change the setting, press *ENTER* to go into edit mode. The display will start blinking. Use the *Up* or *Down* arrow key to switch between the possible options and then press *ENTER* again to accept the new setting and leave edit mode.

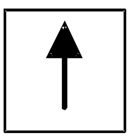
Example: Turn alarm A off.

From the menu, select [AL] [AL.A] [ON.OF]. The analyzer will now display either [ON] or [OFF], which are the two choices. To change the setting, press *ENTER* to go into edit mode. The display will start blinking. Use the *Up* or *Down* arrow key to switch between the possible options. When [ON] is displayed, press *ENTER* again to accept the new setting and leave edit mode.

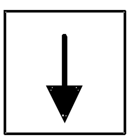
Summary of Key Functions in Edit Mode



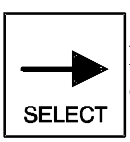
Enters edit mode. The entire display or a single digit will blink to indicate that the analyzer is in edit mode. Press the *ENTER* key again to leave edit mode and accept the new value.



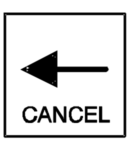
Adjusts blinking digit upward or selects the previous item from the list. If a 9 is displayed then the digit will loop around to show 0.



Adjusts blinking digit downward or selects the next item from the list. If a 0 is displayed then the digit will loop around to show 9.



Numeric values only: move to the right one digit. If blinking is already at last digit, the display will loop to the ± sign on the left.



Numeric values: move left one digit. If blinking is at the ± sign then blinking goes to last character.
Settings: restore the initial value if it was changed. Otherwise leaves edit mode without doing anything.

Illustration 13: Edit keys

Temperature °C or °F

By default, the analyzer will use metric units. This means that temperature will be displayed using degrees Celsius and that the prompt for the temperature input will be [°C]. The analyzer can also use imperial units. For imperial units, temperature will be displayed using degrees Fahrenheit and the prompt for the first temperature input will be [°F] instead of [°C].

In this instruction manual, the temperature input is always identified as [°C] throughout the menus.

To select imperial units for the analyzer, select [unit] from the configuration menu, then go into edit mode and change the [°C] setting to [°F].

Real-Time Clock

The analyzer clock is used for internal date/time stamping of system events and the internal data log. Both the system events and the internal data log are accessed using the IC Net Intelligent Access Program, which is available as option -35. Analyzers purchased with option -34 have a real-time clock which will maintain the correct time and date even when the analyzer power is turned off.

Input Damping

The chlorine, pH and temperature measurements can be damped to provide the user with a means to stabilize rapidly-varying or noisy signals. Damping range is 3 s to 99 s. With 0 seconds, there would be no damping and each reading the analyzer made would be used to directly update the display and 4 mA to 20 mA output. The factory default of 5 seconds adds the next four seconds of readings to the first and divides by five – this gives fast response. Selecting 99 seconds adds the readings for 99 seconds and divides by 99, providing smooth damping out of turbulent readings. Any selection between 3 s and 99 s can be made.

Select [CONF] [in] from the menu. Use the *Up* or *Down* arrow key to select the input to be adjusted, then select the [dA] frame. Press *ENTER*, then change the input damping to the new number of seconds. Press *ENTER* again to leave edit mode.

APPLICATION INFORMATION

Chlorine Chemistry

When chlorine gas is dissolved in water, it hydrolyzes rapidly according to equation 1. This reaction occurs very rapidly, in only a few tenths of a second at 18 °C.

1) $Cl_{2(g)} + H_2O_{(aq)} \longrightarrow HOCl_{(aq)} + HCl_{(aq)}$

Since HCl (hydrochloric acid) is a strong acid, the addition of gaseous chlorine to water results in a lowering of the pH due to the acidic HCl by-product.

The important product of reaction (1) is HOCl or hypochlorous acid. Hypochlorous acid is the disinfectant form of chlorine in water. Hypochlorous acid is unstable because the chlorine molecule is weakly bonded and as a result will react quickly.

Hypochlorous acid is also referred to as free available chlorine, or free chlorine. It is taste free and aggressive against germs and organic compounds.

Chlorine supplied as sodium hypochlorite, calcium hypochlorite, or bleach is in a basic form. When a base is present, a different reaction sequence occurs:

2) $NaOCl_{(aq)} + H_2O_{(aq)} \longrightarrow HOCl_{(aq)} + Na^+ + OH^-$

3) $Ca(OCl)_{2(aq)} + 2H_2O_{(aq)} \longrightarrow 2HOCl_{(aq)} + Ca^{++} + 2OH^-$

In any hypochlorite solution, the active ingredient is always hypochlorous acid. Then once HOCl and OH^- are formed an additional reaction occurs:

4) $HOCl_{(aq)} + OH^- \longleftrightarrow OCl^- + H_2O_{(aq)}$

The proportion of chlorine, hypochlorous acid, and hypochlorite ion in solution depends primarily on pH and somewhat on temperature.

The different forms of chlorine are named as follows:

Cl_2 = chlorine

HOCl = hypochlorous acid

OCl^- = hypochlorite ion

At atmospheric pressure and 20 °C, the maximum solubility of chlorine is about 7,395 mg per liter or 7.395 ppm.

Chlorine and the effect of pH

The most important reaction in the chlorination of an aqueous solution is the formation of hypochlorous acid. The hypochlorous acid form of chlorine is very effective for killing germs. Hypochlorous acid is a 'weak' acid, meaning that it tends to undergo partial dissociation to form a hydrogen ion and a hypochlorite ion. Once in a water environment, HOCl tends to dissociate into H^+ and OCl^- ions.

5) $HOCl_{(aq)} \longleftrightarrow H^+ + OCl^-$

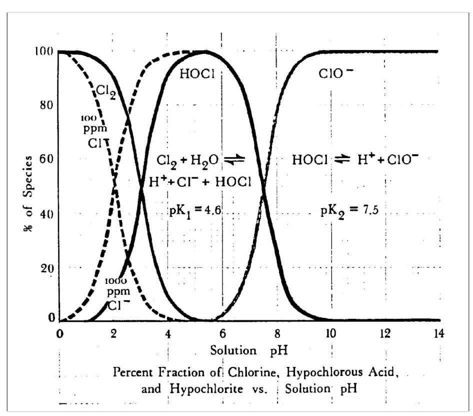


Illustration 14: Chlorine species change vs. pH

In waters between 5 pH and 8.5 pH, the reaction is incomplete and both species are present to some degree. Since H^+ is one of the ions that is formed and it's concentration is expressed as pH, it follows that changing pH levels will influence the balance of this reaction and with it the availability of hypochlorous acid for reaction.

In a water environment, the water pH will affect the chemistry of chlorine due to it's pH sensitivity. This becomes important as pH rises.

6) $H_2O \longleftarrow H^+ + OH^-$ (preference is right-to-left)

Three things follow from this form of ionization:

1. Since the tendency of these two ions to react and form H_2O is much stronger than the tendency of water to break down into the ions, it follows that as the pH rises there are fewer H^+ ions and more OH^- ions.
2. The H^+ released by the breakdown of HOCl (equation 5) react to form water (equation 6) and leave behind residual OCl^- (hypochlorite) ions. Hypochlorite does not react readily, so the chlorine is weaker.
3. If the pH goes down and H^+ ions become readily available again, the OCl^- ions revert to HOCl, which is the killing form of chlorine. This pH change has been known to cause surprise downstream fish kills.

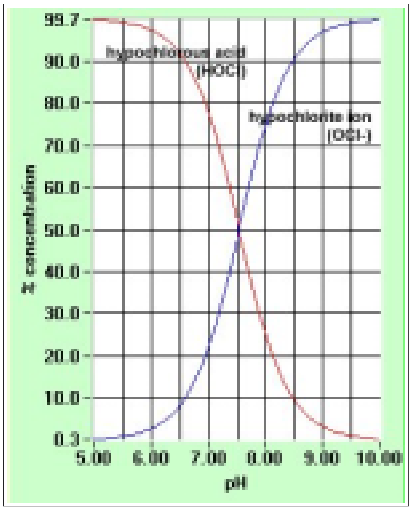


Illustration 15: Chlorine concentration vs. pH

Terminology

In the industry, there are a number of terms used to indicate the various forms of chlorine that are of interest. These terms tend to be used rather loosely and not necessarily consistently. For that reason, IC CONTROLS will define the following terms for purposes of this instruction manual and the 876-25 system:

FREE AVAILABLE CHLORINE refers to the hypochlorous acid (HOCl) form of chlorine only. It is said to be free available because it is the free, uncombined form of chlorine that is effective for killing.

TOTAL FREE CHLORINE refers to the sum of hypochlorous acid (HOCl) and hypochlorite ion (OCl^-). The hypochlorite ion is not effective for killing, but it is in a free form. All of the total free chlorine would be in the form of hypochlorous acid if the pH is low enough.

COMBINED CHLORINE refers to chlorine which is not readily available, is not an effective disinfectant and will not readily convert to hypochlorous acid or hypochlorite ion. For example, chlorine combined as chloramines or organic nitrogen.

TOTAL RESIDUAL CHLORINE refers to the sum of total free chlorine and combined chlorine. In environmental studies low total residual chlorine is of particular interest to ensure no downstream consequences for aquatic life. Total residual chlorine is commonly monitored for final effluent.

Disinfectant Properties of Chlorine

Chlorine is known to be a good disinfectant; it is able to kill living matter in water such as bacteria, cysts, and spores. Exactly how chlorine works to kill is not known. Studies do agree, however, that certain forms of chlorine are more effective disinfectants than others. Whatever the chemical reaction, it is also generally agreed that the relative efficiency of various disinfecting compounds is a function of the rate of diffusion of the active agent through the cell wall. Factors which affect the efficiency of destruction are:

- Nature of disinfectant (type of chlorine residual fraction)
- Concentration of disinfectant
- Length of contact time with disinfectant
- Temperature
- Type and concentration of organisms
- pH

HOCl is the most effective disinfectant of all the chlorine forms and is similar in structure to water. The germicidal efficiency of HOCl is due to the relative ease with which it can penetrate cell walls. This penetration is comparable to that of water, and can be attributed to both it's modest size and to it's electrical neutrality.

The concentration of hypochlorous acid is dependent on the pH, which establishes the amount of dissociation of HOCl to H^+ and OCl^- ions. Lowering the temperature of the reacting solution suppresses the dissociation; conversely raising the temperature increases the amount of dissociation.

The rate of dissociation of HOCl is so rapid that equilibrium between HOCl and the OCl^- ion is maintained, even though the HOCl is being continuously used up.

The hypochlorite ion (OCl^-) form of chlorine is a relatively poor disinfectant because of it's inability to diffuse through the cell wall of microorganisms. The obstacle is the negative electrical charge.

876-25 CHLORINE MEASUREMENT

Introduction

Chlorine in water is a measure of the amount of chlorine, usually thought of as a gas, that is dissolved in the liquid. Chlorine is widely respected as a leading chemical for the treatment of water to make it potable or safe to drink. In addition, free available chlorine is often used to control biological agent growth in water filled industrial systems. The 876-25 directly measures free available chlorine using a model 876-S3 (P/N A2104034) galvanic chlorine sensor.

Galvanic Measuring Cell

The chlorine measuring sensor, P/N A2104034, is an electrochemical cell similar to a battery that produces a current when chlorine is present. By using carefully selected electrodes, in contact with an appropriate electrolyte, a chemical reaction occurs that uses electrons gained from chlorine molecules to produce a galvanic current directly proportional to the concentration of chlorine present. Illustration 16 shows how such an electrode system works in a simple laboratory test. Illustration 17 shows how these scientific principles can be implemented into a working chlorine electrode. Also, unlike an electrolytic cell in which a flow of current produces the chemical reaction, there is no zero-current as galvanic current is naturally zero when zero chlorine is present.

The chlorine sensor uses a galvanic cell separated from the sample by a chlorine permeable PTFE membrane. The cell has a gold cathode in close contact with the PTFE membrane where chlorine gains electrons (is reduced) to become chloride ions, and a silver anode that produces a fixed potential and completes the reaction with the chloride to form silver chloride.

The chemical reactions within the cell are;

At the cathode: $\mathbf{Cl_2 + 2e^- = 2Cl^-}$
At the anode: $\mathbf{2Ag = 2Ag^+ + 2e^-}$
Overall: $\mathbf{Cl_2 + 2Ag = 2AgCl}$

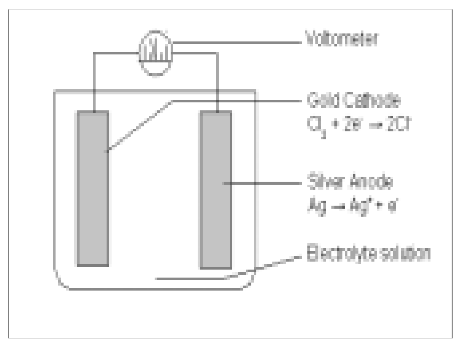


Illustration 16: Basic galvanic cell

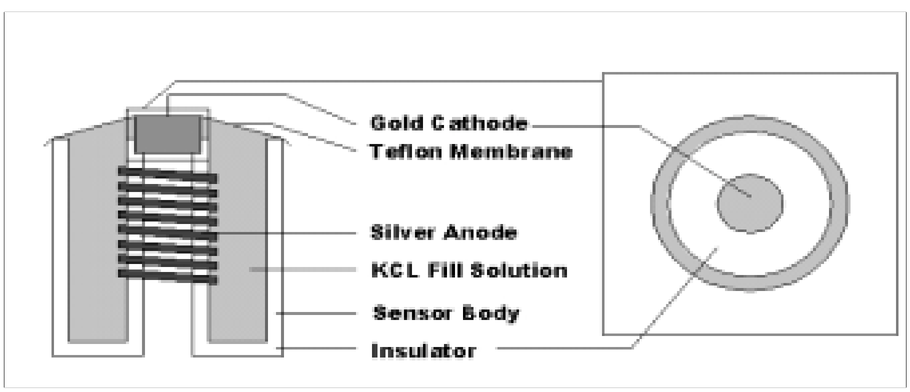
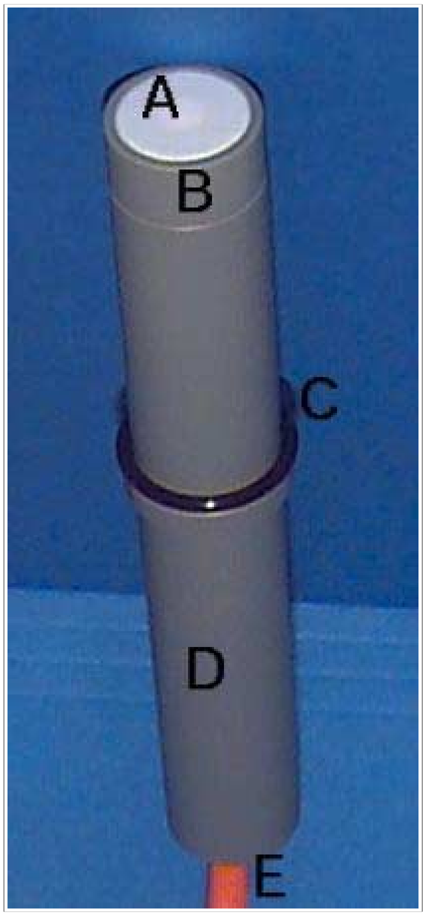


Illustration 17: Galvanic chlorine sensor

CHLORINE SENSOR INSTRUCTIONS

The chlorine sensor is designed for simple maintenance. The sensor is robust and will withstand difficult applications when properly applied and maintained. Follow the instructions in this section to promote proper operation.



Chlorine Sensor, P/N A2104034, Component Identification

A) Membrane

B) Retainer ring

C) O-ring

D) Sensor body

E) Sensor cable

F) Silver coils

Illustration 18: Chlorine sensor, P/N A2104034, component identification

Assembly of the Chlorine Sensor

This procedure should be done over a sink. Protective eye-wear and plastic or rubber gloves are recommended when handling the electrolyte, a salt solution. Wash hands with water if the electrolyte comes in contact with the skin.

1. Galvanic chlorine sensors should have a current drain at all times. Assemble sensor while powered to analyzer OR with a short; coax center to shield. The chlorine sensor has a 5-pin DIN connector and the sensor is shipped with a shorting strap across two pins (refer to illustration 8). Remove this shorting strap prior to connecting to analyzer. Note the location of the pins requiring short for future sensor storage.
2. Disassemble the chlorine sensor by removing the CPVC membrane retainer (see illustration 20) at the sensor tip. Pull straight down on the retainer. The retainer holds the membrane in place and removing the retainer will release the fill solution and expose the silver coils and gold sensing tip. The fill solution is not hazardous so if any gets on the skin simply rinse with water.
3. Discard the used membrane and rinse the retainer and fill solution cavity thoroughly with demineralized water.
4. Replace the membrane using one of the following procedures:

A. Assembly with Membrane Replacement Toolkit

Required Materials

i. P/N A2104035 Membrane replacement toolkit

ii. P/N A2104036 Membrane kit

iii. P/N A1100239 Chlorine sensor fill solution

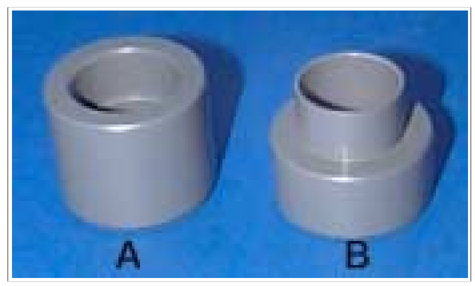


Illustration 19: Membrane toolkit

Membrane Replacement Procedure

NOTE: *A video presentation of this procedure can be viewed at the IC CONTROLS website, www.iccontrols.com.*

a) The membrane replacement toolkit, P/N A2104035, consists of two pieces which fit together into one unit; separate the toolkit into it's individual components (refer to illustration 19). One piece will be a cylindrical shape (A) and the other will resemble a "T" (B).

b) Place the membrane retainer, tapered side up, into the larger diameter hole of the cylindrical component of the membrane replacement toolkit.


Illustration 20: Membrane retainer

c) Place one membrane from P/N A2104036, shiny side up, over the membrane retainer.

d) Place the narrow end of the second component from the membrane toolkit onto the membrane containing component (refer to illustration 21). Press firmly on top of the second component until the two components fit together securely.


Illustration 21: Step d) of membrane replacement procedure

Illustration 22: *Step f) of membrane replacement procedure*

e) Take the sensor and rinse the fill solution cavity with fresh fill solution, P/N A1100239. Hold the sensor in an upright position with the fill solution cavity facing upwards and fill with P/N A1100239 so that the gold tip is completely covered with liquid. Ensure that there are no air bubbles in the solution.

f) Take the assembled toolkit with the larger diameter hole and place over top of the fluid filled sensor tip (refer to illustration 22). Press down firmly until a stop is felt and a click is heard. Some fluid will escape; this is normal and to be expected.

g) Remove the toolkit from sensor tip.

h) Dry the chlorine sensor and blot the tip. Examine the tip — the membrane should be smooth with no wrinkles or cuts and the surface contours of the gold electrode should be clear. There should be no lines from trapped bubbles between the membrane and the gold electrode. If there are no visible problems as described here, then the chlorine sensor is ready to be put into service.

B. Assembly without Membrane Replacement Toolkit

Required Materials

i. P/N A2104036 Membrane kit

ii. P/N A1100239 Chlorine sensor fill solution

Membrane Replacement Procedure

NOTE: *Successful membrane replacement without toolkit P/N A2104035 can be difficult. It is strongly suggested that the toolkit be purchased for ease-of-use.*

a) Take the sensor and rinse the fill solution cavity with fresh fill solution, P/N A1100239. Hold the sensor in an upright position with the fill solution cavity facing upwards and fill with P/N A1100239 so that the gold tip is completely covered with liquid. Ensure that there are no air bubbles in the solution.

b) Place one membrane from P/N A2104036, centered and shiny side down, over the filled sensor tip.

c) Take the membrane retainer (refer to illustration 20) and carefully slide down over the membrane until a stop is felt. Some fluid will escape; this is normal and to be expected.

d) Dry the chlorine sensor and blot the tip. Examine the tip — the membrane should be smooth with no wrinkles or cuts and the surface contours of the gold electrode should be clear. There should be no lines from trapped bubbles between the membrane and the gold electrode. If there are no visible problems as described here, then the chlorine sensor is ready to be put into service.

Inserting Chlorine Sensor in the Flow Fitting

1. Inspect the inside of the quick union fitting for any foreign matter and wipe out any dirt which may be inside. It should appear clean, shiny and bright.
2. Install the union ring-nut and push sleeve on the assembled chlorine sensor by sliding it down the lead wire.
3. Check that the sealing O-ring is on the electrode body, on the sensing tip side of the ledge, or in the O-ring groove of the flow cell.
4. Insert the chlorine sensor into the fitting. Rock the sensor back and forth to pass the O-ring and press firmly all the way down so that the O-ring firmly seats in its groove.
5. By hand, turn the union-nut until finger tight. For higher pressures it may be necessary to use a wrench; however, the components are plastic and care is needed to avoid breakage.

CAUTION: *Do not use a large wrench to turn the sensor. The plastic components of the chlorine sensor could be broken or deformed.*

Removing Chlorine Sensor from Flow Fitting

1. Stop the sample flow and allow system to drain. Remove the pH sensor as per instructions on page 33. Removing the pH sensor will reduce the vacuum effect within the flow cell.

CAUTION: *Removal of the chlorine sensor from a sealed flow cell will vacuum stretch the thin sensing membrane. Stretching the membrane will cause slow response and higher readings at low levels. Parting the membrane will cause chlorine sensor failure.*

2. By hand, turn the union-nut until free. For higher pressures it may be necessary to use a wrench to start turning the nut.
3. Gently rock and pull the chlorine sensor back and forth to ease the O-ring seals back up the compression throat.
4. When the chlorine sensor has been fully removed, wipe the sensor clean and then proceed to the calibration procedure or monthly/yearly maintenance, as necessary.

Zero Test Technique

The best way to zero check at the point of use, where all water and even the air contains some chlorine, is to use a zero chlorine solution available from IC CONTROLS as P/N A1100225 in a 500 mL bottle.

Illustration 23: Zero check

CAUTION: *If zero standard gets on hands, wash with running water. Protective eye-wear and gloves are suggested.*

1. Pour some of the zero chlorine solution, P/N A1100225, into a clean beaker.
2. Immerse the chlorine sensor into the beaker so that it is about 3 inches below the surface of the zero check liquid; refer to illustration 23. Provide slow gentle movement to ensure the chlorine present is consumed. The chlorine sensor should rapidly fall below 0.1 ppm, thus confirming operation of the sensor.

Make sure that the zero check solution is used within 8 hours because the scavenger will be used up with exposure to air by also absorbing oxygen. The remaining zero check solution should be stored tightly capped in it's bottle. The zero solution is "single use", so discard the used zero solution.

Monthly Maintenance

Certain applications may require occasional sensor cleaning. A monthly maintenance check is recommended by visual examination of the sensor cell area. If needed, a soft wipe can be used to blot, plus detergent and water to remove any deposits. Rinse thoroughly after cleaning with water. Run a calibration and return to service if sensor efficiency is above 50 percent.

Note: *Option -51 offers accessories for automatic chemical cleaning that can be retrofitted to the 876-25. Refer to* Appendix D *for details.*

White silt inside the sensor cap may not cause problems. However, if after calibration the sensor response is slow, replace the electrolyte and wipe the coils and surface lightly using a soft wipe, or a little more vigorous cleaning can be done using a toothbrush. Recharge with fresh electrolyte. Calibrate and return the sensor to service.

Semi-Annual Maintenance

Replace the membrane, P/N A2104036, and electrolyte solution, P/N A1100239, following the appropriate membrane replacement procedure in *Assembly of the Chlorine Sensor* section in *Chlorine Sensor Instructions*. Examine the coils for any discoloration or heavy coating. Such coatings should be removed for best performance (caution the silver coils are soft metal, never use force in cleaning). To clean the coils, refer to the *Chemical Cleaning* section for further instructions.

Remove the old membrane from the cell and replace with a new one. Re-assemble the cell, calibrate, check efficiency and if above 50 percent, place in service.

Chemical Cleaning

Chlorine sensors can be refreshed with IC CONTROLS P/N A1100227, chlorine sensor renew solution. This solution is only available in 30 mL bottles. Due to the acidic nature of this solution, the 30 mL bottle is packaged in a baking soda packer for non-hazardous shipment.

Note: *This procedure should be done over a sink. Wear plastic or rubber gloves and protective eye-wear as the solution is acidic. Wash hands thoroughly with lots of water if the solution comes in contact with the skin.*

1. Disassemble the chlorine sensor to expose the silver coils and gold tip.
2. Immerse in cleaning solution as shown in illustration 24 for about 10 minutes, or until deposits disappear.
3. Remove and rinse in distilled or demineralized water; use a small toothbrush to scrub coils to speed removal, if necessary.
4. Repeat steps 2 and 3 until coils and tip look clean and have a shine; re-assemble chlorine sensor with new membrane and fill solution, calibrate and verify efficiency is above 50%.
5. Repeat steps 2 to 4 as necessary to get at least 50% efficiency. If not possible, the chlorine sensor should be replaced.

Illustration 24: Chemical cleaning

Automatic Chemical Cleaning

The model 876-25 offers the option of automatic chemical cleaning. Please refer to *Appendix D - Option -51, Timer Electrode Cleaner* for complete details.

Sensor Storage

Short Term: Immerse the sensor tip in tap water. Wet storage can be used up to two weeks. If the sensor is not connected to the analyzer, the sensor needs to be shorted. Place the shorting strap across the appropriate pins of the sensor connector (refer to illustration 8).

CAUTION: *If a wet sensor dries out in storage, it may become damaged beyond repair.*

Long Term: Disassemble the chlorine sensor tip and pour out the fill solution. Rinse the coils, gold tip, and membrane retainer with demineralized water and blot dry with a paper towel. Re-assemble the chlorine sensor dry, and store dry with the tip covered.

Dry storage can be used for a year or more.

NOTE: *The sensor needs to be shorted only when it is charged (filled with electrolyte) and not connected to a powered analyzer.*

CHLORINE CALIBRATION

The 876-25 chlorine system is calibrated by grab sample; an easy method of standardizing the chlorine measurement without taking the electrode out of the sample. Grab sample standardization method requires the user to determine the actual total free chlorine concentration of the sample using an alternative method.

When grab sample calibration is used, it is the responsibility of the user to ensure that the grab sample taken and the total free chlorine value recorded for it are accurate.

A chlorine calibration kit, P/N A7010001, is supplied with the model 876-25. The calibration kit uses a reagent which develops a violet color which is proportional to the amount of total free chlorine in the sample. The kit contains 30 ampoules, sample cup, and low & high range comparators to measure total free chlorine in the 0 ppm to 1 ppm and 1 ppm to 5 ppm concentration ranges respectively.

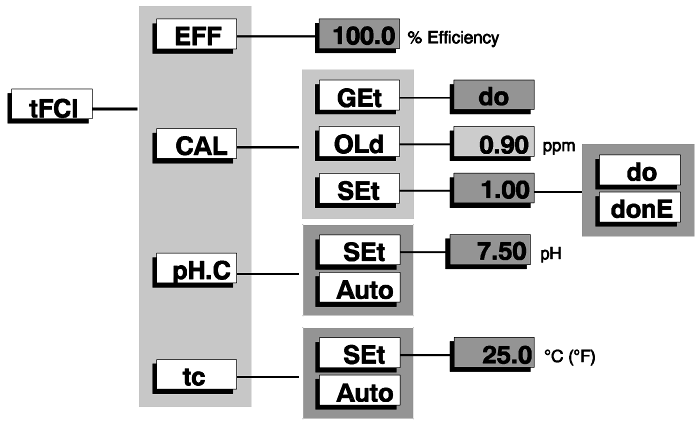


Illustration 25: Chlorine menu

Note: *Keep the kit closed when not in use. The comparators need to be stored in the dark.*


Illustration 26: Chlorine calibration kit, P/N A7010001

Standardizing Chlorine

NOTE: *The pH input should be calibrated first, prior to chlorine standardization. Refer to the* pH Calibration *section.*

1. Press *SAMPLE* to display the [tFCl] reading. Press *SELECT* to reach the first menu, then use the *Up* or *Down* arrow key to display [tFCl].
2. Press *SELECT* then the *Up* or *Down* arrow key to display [CAL].
3. Press *SELECT* then the *Up* or *Down* arrow key to [Get]. Then press *SELECT* again to display a flashing [do]. LEAVE ANALYZER FLASHING!
4. From the analyzer outlet, obtain a representative grab sample cup full of water, then immediately go and press *ENTER* on the analyzer.
5. Take an ampoule from the kit and place the ampoule's tapered tip into one of the four depressions in the bottom of the sample cup. Snap the tip by pressing the ampoule towards the side of the cup. The sample will fill the ampoule and begin to mix with the reagent. A small bubble of inert gas will remain in the ampoule to facilitate mixing.

CAUTION: *Do not break the tip of the ampoule unless it is completely immersed in your sample. Accidentally breaking the tip in the atmosphere may produce a "jack-hammer" effect, shattering the ampoule.* **Wear eye protection when working with these ampoules.**

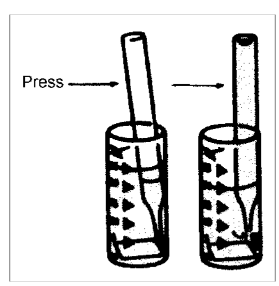


Illustration 27: Method for breaking the ampoule

6. Remove the fluid-filled ampoule from the cup. Mix the contents of the ampoule by inverting it several times, allowing the bubble to travel from end to end each time.
7. Wipe all liquid from the exterior of the ampoule and wait **1 minute**.
8. After 1 minute, use the appropriate comparator to determine the level of chlorine in the sample. Write down the chlorine value.

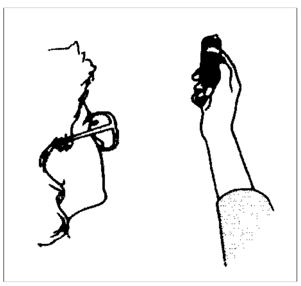
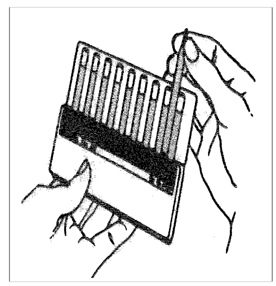
Low-range Comparator: ***0 ppm to 1 ppm***	***High-range Comparator:*** ***1 ppm to 5 ppm***
The ampoule is placed in the center tube, flat end downward. The top of the cylinder is then directed toward a source of bright light while viewing from the bottom. Hold the comparator in a nearly horizontal position and rotate it until the standard below the ampoule shows the closest match.  *Illustration 28: Using the low-range comparator*	The comparator should be illuminated by a strong white light directly above the comparator. The filled ampoule should be placed between the color standards for viewing. It is very important that the ampoule be compared by placing it on **both** sides of the standard tube before concluding that it is darker, lighter, or equal to the standard.  *Illustration 29: Using the high-range comparator*

Table 1: How to use the comparators

9. Install the chlorine calibration value, determined in step 8, into the 876 as follows:
   Press *SAMPLE* then *SELECT* to display [tFCl]. Press *SELECT* to display [CAL], then press *SELECT* to display [Get], then press *Up* arrow to display [SEt]. Press *SELECT* to display numeric value, then press *ENTER* to get the numeric value to flash. Edit the numeric value to the new value determined from step 8. When the flashing value is the chlorine value from step 8, press *ENTER* to get the analyzer to accept the value, then press *SELECT* to display flashing [do]. Press *ENTER* to get the 876 to accept the chlorine calibration by displaying [Done].
10. Press *SAMPLE* to display the [tFCl] or total available chlorine reading in mg/L or ppm . Write down this value.
11. Press *Down* arrow key to display [HOCl] or free available chlorine in mg/L or ppm. Write down this value.
12. Press *SELECT* to display [tFCl], then press *SELECT*, then the *Up* arrow key to display [EFF]. Press *SELECT* to display the sensor efficiency in percent. Write down this value.

Note: *Keeping a written calibration record will show how your unit trends over time.*

The 876 analyzer is now reading chlorine and tracking chlorine changes in the water sample.

pH and Temperature impact on Chlorine

The measurement of the chlorine concentration is done by the galvanic sensing electrode. However, the chlorine chemistry of the sample will change with both temperature and pH. Illustration 15 shows how the relative concentrations of hypochlorous acid and hypochlorite ion shift with a change in the water pH. This same relationship is also dependent on the temperature of the solution, as the curves will shift with changes in the temperature. The 876-25 includes a temperature input and pH input to compensate for these changes. A pH sensor is provided to measure the pH of the sample and temperature compensation is provided via a temperature sensor in the chlorine electrode.

A method has been provided in the analyzer program to change the compensation method for temperature compensation and pH compensation from automatic to manual. Providing a method of manual temperature compensation and/or manual pH compensation allows the analyzer to continue measuring free available chlorine and total free chlorine in the event that the temperature sensor and/or pH sensor are malfunctioning or absent.

Manual Temperature Compensation

From the main menu, select [tFCl] [tc]. At this point either [Auto] (for automatic temperature compensation), or [SEt] (for manual temperature compensation set-point) will be displayed. To change the setting from [Auto] to [SEt] press *ENTER* to edit the current setting. The display will start blinking, indicating that a selection needs to be made. Use the *Up* or *Down* arrow key to display [SEt]. Press *ENTER* to select manual temperature compensation.

With [SEt] as the current display, press *SELECT* to display the temperature setting for manual temperature compensation. If the current value needs to be changed, press *ENTER* to edit the current setting. The display will start blinking. Use the *Up* or *Down* arrow keys to display the desired temperature for manual temperature compensation. Press *ENTER* to accept the currently displayed value.

Manual pH Compensation

From the menu select [tFCl] [PH.C]. At this point either [Auto] (for automatic pH compensation), or [SEt] (for manual pH compensation set-point) will be displayed. To change the setting from [Auto] to [SEt] press *ENTER* to edit the current setting. The display will start blinking, indicating that a selection needs to be made. Use the *Up* or *Down* arrow key to display [SEt]. Press *ENTER* to select manual pH compensation.

With [SEt] as the current display, press *SELECT* to display the pH setting for manual pH compensation. If the current value needs to be changed, press *ENTER* to edit the current setting. The display will start blinking. Use the *Up* or *Down* arrow keys to display the desired pH value for manual pH compensation. Press *ENTER* to accept the currently displayed value.

pH SENSOR INSTRUCTIONS

Preparation for Use

1. Moisten the pH sensor body with tap water and carefully remove the tape and orange plastic storage cap. Caution should be used in removing this cap; pull straight down. Do not bend the body of the pH sensor. This can result in damage to the internal element.
   Note: *Save the lower cap for later use in storage of the pH sensor.*
2. Rinse away any deposits on the exposed pH bulb and junction area with tap water.
3. For first time use, or after long term storage, immerse the pH electrode in 4 pH buffer for 30 minutes. This hydrates the pH bulb and prepares the reference junction for contact with test solutions.
4. If air bubbles are visible inside the pH bulb, shake the electrode downward to fill the bulb with solution.
5. IC CONTROLS electrodes are shipped in a pH electrode storage solution buffered to approximately 7 pH. These electrodes are often ready for use immediately with typical accuracy of ± 0.2 pH without buffering; however, it is strongly recommended that buffered calibration be performed.
6. The pH sensor is ready to be placed in service.

Inserting pH Sensor into Flow Fitting

Insertion sensors should be examined for good clean sealing surfaces and installed carefully. Clean seals such as O-rings should be lubricated with silicone grease to ensure liquid tight performance.

Remove the storage cap then carefully push the sensor into the insertion fitting until it is seated against the stop. Tighten the retainer nut to hold the sensor firmly in place. Let the vessel fill with liquid. The pH sensor should now read the liquid pH.

Removing pH Sensor from Flow Fitting

Simply turn off the sample flow and allow the pressure to drop to zero, then undo the retaining nut and carefully remove the pH sensor from the flow cell.

Electrode Maintenance

The pH sensor needs to be calibrated periodically to maintain accurate measurements. IC CONTROLS recommends that the electrode be calibrated every 30 days. Depending on the process, it may need to be calibrated more frequently, eg. weekly or even daily. Frequent calibration is especially important if accurate measurements are required.

Over time, electrode performance will degrade. The glass bulb becomes less responsive to pH and the reference electrode becomes depleted. The electrodes will need to be replaced after several years of use or, depending on the harshness of the process, after several months.

Sensor Storage

Short Term: Rinse the pH sensor in demineralized water then store in a plastic shipping cap of 4.0 pH buffer solution.

Long term: Clean the pH sensor in pH electrode wash solution, P/N A1100091, rinse in demineralized water, then store in a plastic shipping cap of pH electrode storage solution, P/N A1100090.

Monthly Maintenance

Remove the sensor from the flow cell, rinse in water, remove any significant deposits, and then check by calibration in 7 pH for offset and then 4 pH or 10 pH buffer for slope.

If the calibration turns up a caution or error message in the 876 analyzer, then follow the appropriate solution. Also, refer to *Troubleshooting* section.

If the calibration is good, keep a log of the pH offset and slope at each monthly calibration.

The pH sensor is now ready to return to service.

Yearly Maintenance

Check the pH offset log. If the pH offset has changed more than 30 mV over the past year, it may need to be chemically cleaned – follow the *Chemical Cleaning of Sensor* procedure.

Check the pH slope (efficiency) log. If the efficiency has dropped below 85%, it may need to be chemically cleaned and restored – see *Chemical Cleaning of Sensor* and/or *Restoring Electrode Response* in the *Troubleshooting* section.

After all the above checks, plus chemical cleaning and/or restoring procedures, follow the monthly maintenance procedure. Start a new log with the improved values.

When to Clean Sensors

Various factors can affect the pH reading; scale, biological growth, oil, wax, gum, etc., all reduce the area for hydrogen ion to react with the glass. Biological microbe growths can also produce local pH environments inside their growth deposit, which can be quite different from the true process pH. Periodic cleaning of pH sensors will remove these deposits, restore the pH glass surface, reference junction and thus the pH accuracy.

Mechanical Cleaning of Sensor

The sensor will require cleaning if sludge, slime, or other deposits build up in the internal cavities of the sensor.

Wherever possible, clean with a soft brush and detergents. General debris, oils, films, biological growths, and non-tenacious deposits can be removed in this way.

Use a soft flat brush and a beaker or bucket of water with a good liquid detergent. Take care not to scratch the pH electrode glass surface; it is thin, fragile and easily broken.

All the wetted surfaces of plastic body sensors should be washed with a soft cloth. This will return their appearance to like-new condition and remove sites for buildups to occur.

When to Chemical Cleaning

After mechanical cleaning, as above, check the sensor against a pH buffer. If the sensor is still not developing the pH reading properly in the pH buffer, proceed to the *Chemical Cleaning* procedure; otherwise return the sensor to the process.

Chemical Cleaning of Sensor

IC CONTROLS offers a pH sensor chemical cleaning kit containing solutions and necessary cleaning items as P/N A1600054.

Note 1: *A suitable place to do chemical cleaning is at a counter or bench with a laboratory sink, with a chemical drain where waste is contained and treated before release.*

Note 2: *IC CONTROLS kits are kept small and portable so that they can be taken to installation sites, together with a plastic bucket of water (for rinsing) and a rag/towel (for drying). Waste materials (particularly acid leftovers) should be returned to the laboratory for disposal.*

CAUTION: *Use extra care when handling the cleaning solution as it contains acid.* ***Wear rubber gloves and adequate facial protection when handling acid.*** *Follow all P/N A1100091 & P/N A1100094 MSDS safety procedures.*

a) Set up the cleaning supplies where cleaning is to be performed. Lay out the sensor cleaning brush, syringe, cleaning solutions and rinse solutions, plus the beakers and sensor**.**
Note: *Ensure your cleaning solution beaker is on a firm flat surface since it will contain acid.*

b) First remove the pH sensor from the process and examine it for deposits. Use the sensor cleaning brush and tap water to loosen and flush away any deposits within the measurement area. Detergent can be added to remove oil films and non-tenacious deposits. Hard scales and other tenacious deposits may require chemical cleaning.

c) CHEMICAL CLEANING: Fill a beaker ¾ full of pH electrode wash solution, P/N A1100091.

d) Lower the pH sensor into the center of the beaker until the entire tip is submerged.

e) Allow the sensor to sit in this solution for a few minutes and then check to see if the pH electrode and reference junction appear clean. If not entirely clean, allow sensor to sit in solution until clean. Stubborn deposits can be removed with the brush and syringe, to squirt wash solution into hard to reach areas.

CAUTION: *Use great care when brushing and squirting acid.* ***Wear rubber gloves and facial protection.***

f) Rinse the cleaned sensor thoroughly in tap water and then with demineralized water for a second rinse prior to calibration.

g) Check the sensor against a pH buffer close to the application pH. If the sensor is still not reading properly (± 0.5 pH) in the buffer, clean again using gentle scale remover, P/N A1100094, following steps h) to l).

h) CHEMICAL DESCALING: Fill a beaker ¾ full with gentle scale remover, P/N A1100094.

i) Lower the pH sensor into the center of the beaker until the entire tip is submerged.

j) Allow the sensor to sit in this solution for a few minutes and then check to see if the pH electrode and reference junction appear clean. If not entirely clean, allow sensor to sit in solution until clean. Stubborn deposits can be removed with the brush and syringe to squirt scale remover into hard to reach areas.

CAUTION: *Use great care when brushing and squirting acid.* ***Wear rubber gloves and facial protection.***

k) Rinse the cleaned sensor thoroughly in tap water and then with demineralized water for a second rinse before calibrating.

l) Check the sensor against a pH buffer solution close to the application pH.

m) A clean and rinsed pH sensor should read near 7 in pH 7 buffer. If it does not, troubleshoot the pH sensor, wiring and analyzer.

pH CALIBRATION

The pH input is calibrated using one of two methods. A one-point standardization adjusts the electrode offset while maintaining the previous slope. The two-point calibration combines the results of the standardization with the results of the buffer 2 calibration and calculates the slope as well as the offset.

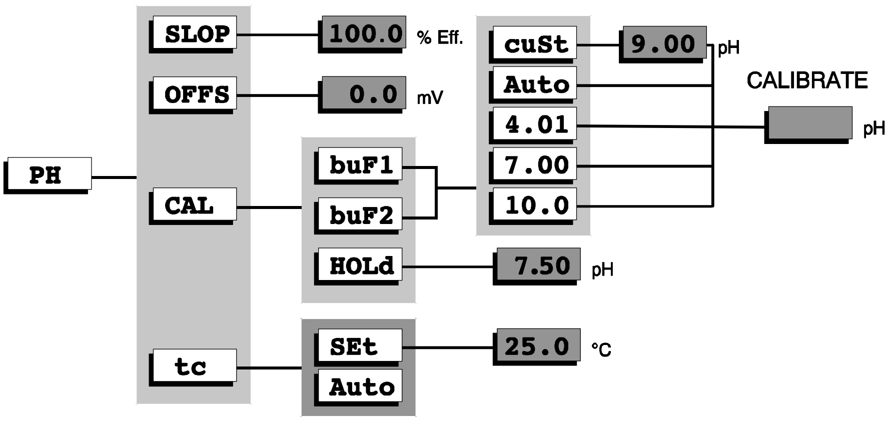


Illustration 30: pH menu

A calibration is easily accomplished by selecting an appropriate buffer, placing the electrode in the buffer solution, and letting the analyzer do the rest. The analyzer tests for electrode stability and performs many diagnostic tests during calibration. Automatic stability testing takes most of the guesswork out of deciding whether a reading is acceptable or not. The internal diagnostic tests will activate caution or error messages if faulty operation is suspected or detected. Errors detected during calibration will not cause the analyzer to lock up.

Buffers automatically recognized by the 876 are:

Buffer	*Part Number, 500 mL bottle*	*Part Number, 6-pack*
4.01 pH, red	A1100051	A1100051-6P
7.00 pH, green	A1100052	A1100052-6P
10.0 pH, blue	A1100053	A1100053-6P

Selecting a pH Buffer

pH buffers provide the simplest and most accurate method of calibrating the pH sensor and analyzer.

First Buffer: The first step is to use 7 pH buffer to calculate the mV offset of the electrode from the theoretically perfect 0 mV. pH 7 buffer is used because it simulates 0 mV thus making it the best standard since the electronics are also at this 0 mV reference point.

Second Buffer: The next step in the calibration is to use a second buffer (usually 4 pH or 10 pH). When choosing which buffers to use in calibration, it is best to select buffers that fall on both sides of the normal operating pH range. By using these two buffers, the slope calculation will encompass the normal pH, thus giving the most accurate pH measurement. Either of these buffers, pH 4 or pH 10, gives a large enough span relative to the pH 7 buffer that a good slope can be calculated. When performing the two point calibration, a percent value will be given in microprocessor based pH analyzers. The closer to 100% the slope is, the better the efficiency and thus the performance of the electrode.

The model 876-25 has been programmed to recognize the three buffers most commonly used for calibration: pH 4, pH 7, and pH 10. To achieve greater accuracy, the temperature compensated values for these buffers are calculated by the analyzer. Simply place the electrodes in the buffer solution and the analyzer will select the correct buffer value, allowing for an offset of up to ± 1.3 pH units.
Note: [Auto] must be selected in the calibration menu for this feature to work.

Temperature Dependence of Buffers

The pH of a solution is dependent on temperature. To achieve greater accuracy, the temperature-compensated values for the 4 pH, 7 pH and 10 pH buffers are calculated by IC CONTROLS analyzers.

The graphs show the temperature-dependence of the standard buffers. The TC-curves have been programmed into the IC CONTROLS analyzer. The actual pH value of each of the three standard buffers will be used.

Example: Calibrate using the pH 4.01 buffer (at 25 °C). The temperature of the buffer is 50 °C. The analyzer will use the pH value of 4.05.

Incorrect Buffer Selection by the Analyzer

If the offset is known to be greater than ± 77 mV, or if the analyzer selected the wrong buffer using automatic buffer recognition, then it is necessary to specify which buffer is being used. This is done by selecting [4.01], [7.00], or [10.0] then an offset of ± 4 pH units is allowed and temperature-compensated values are still used.

Other Buffer Values or Custom Buffers

If a buffer with a pH value other than pH 4, pH 7, or pH 10 is to be used, select [cuSt] (custom value), then enter a value between 0 pH and 14 pH. Buffer values entered this way are not temperature compensated; the buffer is assumed to have the specified pH value at the current temperature. Offsets of up to ± 4 pH units are allowed.

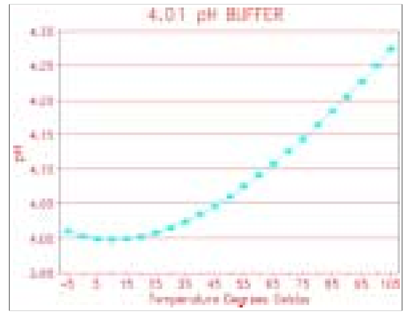


Illustration 31: Temperature compensated pH 4 buffer

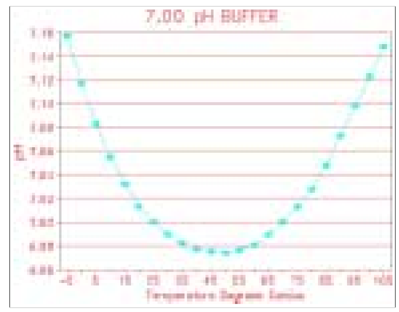


Illustration 32: Temperature compensated pH 7 buffer

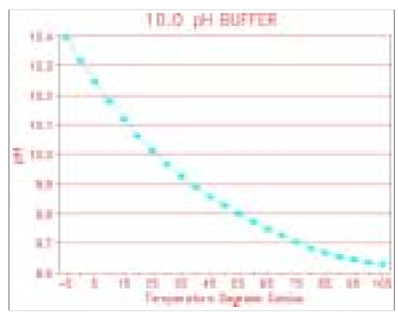


Illustration 33: Temperature compensated pH 10 buffer

pH Buffer Use and Maintenance

A pH measurement is only as good as the calibration, and the calibration is only as good as the buffers. The following guidelines for buffer maintenance will ensure accurate pH calibration and thus accurate pH measurement.

- Buffers have a limited shelf life. IC CONTROLS suggests a one (1) year shelf life for unopened pH buffers. Store buffers at room temperature.
- Discard used buffer - do not return used buffer to the stock bottle.
- Protect buffers from exposure to air as atmospheric carbon dioxide lowers the pH value of alkaline buffers. Other trace gases found in industrial environments may also affect the buffer pH. Molds resulting from airborne spores may accumulate in neutral and acidic buffers and change the pH value as well.
- Rinse sensor with demineralized water before placing in buffer to prevent carryover contamination. A few drops of demineralized water will not visibly alter the pH. Do not wipe the sensor dry as wiping may induce a static charge which could result in noisy readings.

Standardizing — Single-Buffer Calibration

Standardizing the analyzer causes the analyzer to calculate the offset for the pH electrode; indicated as [OFFS] in the [PH] menu. The electrode slope value determined during the last buffer 2 calibration will be maintained; indicated as [SLOP] in [PH] menu.

1. Press *SAMPLE* to display the [tFCl] reading. Press *SELECT* to reach the main menu, then use the *Up* or *Down* arrow keys to display [PH]. Press *SELECT* then use the *Up* or *Down* arrow keys to display [CAL].
2. Press *SELECT* again, then use the *Up* or *Down* arrow keys to display [buF1].
3. Press *SELECT* again to reach the next menu. A buffer value needs to be determined with which to calibrate the analyzer. Use either automatic detection, [Auto], a custom value, [cuSt], or one of the standard buffers, [4.01], [7.00] or [10.0]. For further details, see *Selecting a Buffer* for an explanation of the buffer selection process.
4. Rinse the pH sensor in demineralized water to remove drops of process liquid.
   Note: *Although pH buffers are formulated to resist pH change, mixing in strong foreign ions can cause pH shift and resultant calibration to incorrect pH value. Dirt deposits, biological growths, and any other contaminants should be removed from the pH sensor body and tip prior to calibration.*
5. Place the electrode in the selected buffer solution, then press *SELECT* to start the calibration process. The display will show a flashing pH reading to indicate that the analyzer is reading pH and is testing for stability.

The calibration procedure is fully automatic from here on. As soon as the electrode has stabilized, the display will stop flashing, the electrode offset will be calculated, and the new offset will be entered in memory.

It is, however, possible to override the analyzer. The *ENTER* key may be pressed before the electrode has stabilized, forcing the analyzer to calibrate using the current pH input. Also, the calibration may be redone or started over at any time. Press *CANCEL* to display the selected buffer (eg. [Auto]), then *SELECT* to restart the calibration.

If the analyzer detects or suspects any problems during calibration, an error and/or caution message will appear. Refer to *Error Messages* for a description of each message.

If an error has occurred, the standardization was not successful. The analyzer has kept the value from the last successful calibration. Press any key to acknowledge the error. The analyzer will return to the buffer selection menu and display the selected buffer, eg. [Auto]. Take corrective action and retry the calibration.

If a potential problem has been detected; seen by a caution message, then the analyzer has successfully completed calibration. The caution message simply informs the user that poor performance is suspected.

Press any key to resume normal operation after a caution or error message has appeared.

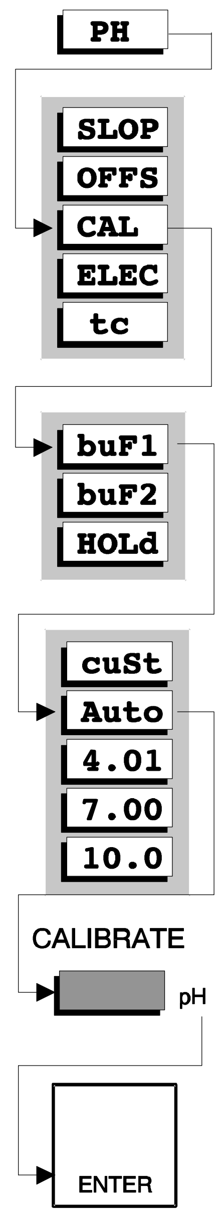


Illustration 34: pH standardization

Calibrating – Two-Buffer Calibration

Calibrating the analyzer involves calculating both the offset and the slope (electrode efficiency) for a particular electrode pair. The electrode slope will be calculated as a percentage of Nernstian response.

1. Calibrate the offset with 7 pH buffer as [buF1], buffer 1, by following the procedure for *Standardizing - Single Buffer Calibration*. Return to the calibration menu and display [buF2]. Press *SELECT* to reach the buffer selection menu.
2. Use the *Up* and *Down* arrow keys to select either automatic detection, [Auto], a custom value, [cuSt], or one of the standard buffers, [4.01], [7.00] or [10.0]. The second buffer should be at least 2 pH units higher or lower than the buffer used for the standardize procedure. Refer to the section entitled *Selecting a Buffer* for an explanation of the buffer selection process.
3. Rinse the pH sensor in demineralized water to remove drops of pH 7 buffer. **Note**: *Carryover of old buffer into different fresh buffer will decrease the pH difference between the buffers producing an efficiency calibration error.*
4. Place the rinsed sensor into the second buffer and press *SELECT* to start the calibration process.

The calibration with the second buffer works similar to a standardization, except that additional error checking is possible and the electrode efficiency will be calculated; indicated as [SLOP] in the [PH] menu. If an error occurs at this point, the settings from the standardization ([buF1] selection) will be kept. Either retry the calibration with a second buffer ([buF2]), or resume normal operation with the settings from the standardization.

Note: ***Discard used buffer after calibration.*** *Used buffer usually picked up carryover buffer and/or contaminants that cause pH error if re-used.*

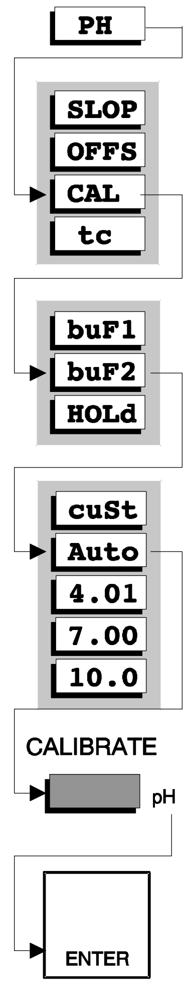


Illustration 35: Buffer 2 calibration

Manual Adjustment of Offset and Slope

It is possible to bypass the regular calibration procedure and edit the slope or offset directly. Offset and slope are protected by level 1 security, which is the same security as the other calibration procedures.

When the offset or slope are adjusted directly, there is no way for the analyzer to verify the accuracy of the adjustments made. However, slope and offset warnings are given whenever the adjustments fall outside the preset 'safe' regions. Unlike a normal calibration, the manual adjustments will allow slope adjustments outside 60% to 110% slope efficiency or offset adjustments greater than ± 4 pH units (about 240 mV). The usual error messages will come up but the specified new values will be installed nonetheless.

An alternate calibration method, grab sample, may be performed as follows:

1) Take a pH reading using a different method, eg. portable meter.

2) Go to [PH] [CAL] [buF1] [cuSt] and edit the value to the pH value obtained in step (1).

IC CONTROLS advises that the operator use one of the regular calibration procedures whenever possible.

ERROR MESSAGES

Detected errors and/or cautions can be displayed by the analyzer. From the main menu select [Err]. If there are no error or caution messages, [NONE] will be displayed, otherwise scroll through the error list using the *Up* and *Down* arrow keys. Errors and cautions cannot be removed from this list directly; each error or caution will be removed automatically when appropriate, eg. errors associated with improper calibration will be cleared after a successful calibration.

Input/Source	*Input Number for Error/Caution Messages*
Chlorine	1
Temperature	2
pH	3
Alarm A	7
Alarm B	8

Table 2: Input number designation for error messages

Error messages are numbered. Errors 1 through 5 are identified as [En.e] where *n* is the input number and e is the error number. Messages 6 through 9 are less serious and are identified as cautions instead, eg. [CAn.e].

Off-scale errors for chlorine are not numbered and are identified as [+Err] and [-Err], depending on whether the input is at the top or the bottom of the scale. The off-scale error is displayed instead of the sample reading and does not show up in the error menu with the numbered error messages, if any.

Error message indicators can be annoying when one has already been made aware of them. A method has been provided to turn off the error LED and the fault alarm for a particular error message. Refer to *Acknowledging an Error Message* below for the exact procedure.

The error LED will remain on as long as there is an unacknowledged error or caution message or as long as any input is off-scale. Each source of error must be removed or acknowledged before the error LED will go off.

Acknowledging an Error Message

Select [Err] from the main menu. Use the *Up* or *Down* arrow key until the error message to be acknowledged is displayed.

Errors are displayed with either a positive (+) sign or a negative sign (-) in front. The + sign is used to indicate an active or unacknowledged error, the - sign indicates an inactive or acknowledged error. Acknowledging the error will change the sign from + to -.

Press *ENTER* to go into edit mode. The + or - sign will be flashing. Use the *Up* or *Down* arrow key to change the sign, then press *ENTER* again.

An acknowledged error message is cleared for one occurrence of the error only. If the error reappears, the sign changes from - to + and the error message must be acknowledged again.

Messages for Chlorine Input

Error	***Description***	***Causes***	***Solutions***
E1.0	Reading is off-scale. Display shows [+Err].	The internal A/D converter is at the top of the scale. The analyzer cannot measure higher chlorine values.	The analyzer is at the limit of it's measuring capability. Check the sensor setup to ensure that the sensor is operating properly. Service or replace the sensor if necessary.
			The analyzer needs electronic adjustments. Arrange for servicing.
E1.2	Electrode efficiency would be less than 20%. Previous setting retained.	Improper electrode setup or electrode failure.	Set up electrode, then redo calibration. Also refer to *Troubleshooting* section.
E1.3	Sensor efficiency would be more than 300%. Previous setting retained.	No chlorine signal or signal from sensor very weak.	Check electrode connection, then redo calibration. Also refer to *Troubleshooting* section.
E1.4	pH compensator is off-scale.	pH sensor is not connected.	Check pH sensor connections and/or select manual pH compensation.
E1.5	Temperature compensator is off-scale.	TC is not connected.	Check TC connections or install TC.
		Process is outside of TC operating range of -5 °C to 105 °C.	Use manual temperature compensation.

Messages for Temperature Input

Error	***Description***	***Causes***	***Solutions***
E2.1	Temperature reading is off-scale. Temperature is less than -5 °C.	Temperature is less than -5 °C.	Verify process and sensor location.
		Electronic temperature calibration necessary.	Follow procedure in *Hardware Alignment* section.
E2.2	Temperature reading is off-scale. Temperature is greater than 105 °C.	Temperature compensator is not attached.	Attach temperature compensator.
			Connect resistor to TC terminals to simulate a constant temperature. Refer to *Hardware Alignment* section.
		Temperature is greater than 105 °C .	Verify process and sensor location.
		Electronic temperature calibration necessary.	Follow procedure in *Hardware Alignment* section.

Messages for pH Input

Error	***Description***	***Causes***	***Solutions***
E3.1	Electrode has not stabilized after 5 minutes of calibration.	Poor electrode performance.	Check electrode, redo calibration.
E3.2	Electrode has stabilized, but offset > ± 1.3 pH units. This error generated by auto detection of pH 4, pH 7, and pH 10 buffers only. Previous offset is retained.	Large offset in electrode.	Calibrate specifying custom, pH 4, pH 7, or pH 10 buffer to allow for offsets of up to ± 4 pH units. Perform electrode maintenance.
		Wrong buffer used for calibration Only pH 4, pH 7, and pH 10 buffers can be detected automatically.	Specify the correct pH value for the standard and redo the calibration.
E3.3	Electrode has stabilized, but offset > ± 4 pH units. Previous offset retained.	Wrong buffer used for calibration.	Redo calibration specifying correct buffer.
		Bad electrode.	Perform electrode maintenance.
		Electrode not connected.	Check connections, redo calibration.
E3.4	Electrode efficiency less than 60% or greater than 110% Nernstian response; slope is too flat or too steep. Previous calibration is retained.	[buF2] calibration done before [buF1] calibration.	Calibrate using [buF1] for first buffer, then go to [buF2] to calibrate for slope.
		Buffers used in [buF1] and [buF2] are too close together or are the same buffer.	Select buffers which are further apart to allow for more accurate slope calculation.
			Perform [buF1] calibration only and use default slope.
		Wrong buffer specified.	Redo calibration with correct buffer.
E3.5	Temperature compensator is off-scale.	TC is not connected.	Check TC connections or use manual TC.
		Process is outside of TC operating range of -5 °C to 105 °C.	Redo calibration within TC operating range or use manual temperature compensation.
CA3.6	Offset > 1.3 pH units.	Large offset in reference electrode or electrode depleted.	Check electrode, service or replace as required.
		Bad buffer used for calibration.	Use fresh buffer.
CA3.7	Slope efficiency less than 85% or greater than 102% Nernstian response.	Poor electrode pair performance.	Check both the reference and the glass pH electrode. The glass may need to be etched or cleaned.
		Bad buffer used for calibration.	Use fresh buffer.
		Buffers were too close together.	Use buffers which are further apart.
		Electrodes did not stabilize.	Allow more time for the analyzer to stabilize, repeat calibration if necessary.
			Use buffer closest to pH 7 as first buffer.

Error	*Description*	*Causes*	*Solutions*
+ Err	pH reading off-scale; pH > 14.	Process too caustic for accurate measurement.	Verify process.
		Large electrode offset.	Service or replace electrode.
- Err	pH reading off-scale; pH < 0.	Electrode not connected.	Connect electrode or check connections.
		Electrode not responding.	Etch glass electrode. Clean reference electrode.
		Process too acidic to be measured.	Verify process.

Caution Messages for Alarms

Caution Number	*Description*
CA7.5	Alarm A, “No Chlorine” alarm
CA7.6	Alarm A, HIGH alarm
CA7.7	Alarm A, LOW alarm
CA7.8	Alarm A, DEVIATION alarm
CA7.9	Alarm A, FAULT alarm
CA8.5	Alarm B, “No Chlorine” alarm
CA8.6	Alarm B, HIGH alarm
CA8.7	Alarm B, LOW alarm
CA8.8	Alarm B, DEVIATION alarm
CA8.9	Alarm B, FAULT alarm

DISPLAY PROMPTS

[_ . _] Timer menu
[+_ . _] Set time for on-cycle
[-_ . _] Set time for off-cycle
[AL] Alarms
[AL.A] Alarm A
[AL.b] Alarm B
[Auto] Automatic compensation
[bAud] Baud rate
[buF1] Buffer for standardizing or first buffer for calibration
[buF2] Second buffer for calibration
[°C] Temperature in degrees Celsius; temperature input; use metric units
[CAL] Calibrate
[CHIP] Chip. Is this analyzer equipped with a real-time clock chip?
[CF] Membrane compensation factor
[CLSd] Normally closed alarm contact
[CONF] Configuration
[cur] Signal output in mA, or current
[cuSt] Custom buffer value for calibration
[dA] Input damping time in seconds
[dAtE] Date. Real-time clock setting for day of month
[dEv] Deviation alarm
[dFLt] Default
[dLAY] Alarm activation delay
[do] Do — press to do reset/clear action
[donE] Done – reset/clear action has been accepted
[EFF] Efficiency
[Err] Error
[Er.94] RAM checksum failed. Some settings may be lost
[Er.95] EPROM checksum failed
[° F] Temperature in degrees Fahrenheit; temperature input; use imperial units
[FLt] Fault alarm, selectable function for alarm B
[GEt] Get the grab sample calibration reference reading
[HI] High alarm; high limit (20 mA) for 4 mA to 20 mA output window
[HOCl] HOCl, hypochlorous acid, free available chlorine input
[HOLd] Output hold
[hour] Hour. Real-time clock setting
[hund] Hundredth of a second. Real-time clock setting
[iLOG] Internal data log menu; refer to IC Net section
[in] Input – OR – Minute for real-time clock setting
[init] Initialize all program settings to factory defaults
[LO] Low alarm; low limit (4 mA) for 4 mA to 20 mA output window
[no.Cl] No chlorine alarm
[NodE] Node number
[NO.NC] Normally Open/Normally Closed
[NONE] No membrane compensation
[OFF] Off
[OFFS] Offset

[OLd] Old. The grab sample calibration old reading
[ON] On
[ON.OF] On/off switch
[onth] Month. Real-time clock setting
[OPEN] Normally open alarm contact
[out] 4 mA to 20 mA analog output channel
[out1] Output 1
[out2] Output 2
[PH] pH input
[pH.C] pH compensation
[rtc] Real-time clock
[SEC] Second. Real-time clock setting
[SEr] Serial menu; refer to IC Net section
[SEt] Set-point; select manual compensation value; set grab sample calibration
[SLOP] Calculated slope for pH input, given as % Nernstian response
[StAr] Start
[StAt] Current status of timer
[Stby] Standby mode
[Std.] Standard membrane
[tc] Temperature compensation
[tFCl] Total free available chlorine input; HOCl + OCl^-, hypochlorous acid plus hypochlorite ion
[unit] Display of units used for analog outputs and alarms
[YEAr] Year. Real-time clock setting

GLOSSARY

Electrode
Both a sensing and a reference electrode are needed for the analyzer to measure the process. Commonly these are combined into one and referred to as a combination electrode. The temperature sensor may be built into the electrode as well.

EPROM
Erasable/Programmable Read Only Memory. The EPROM chip holds the program which determines the functioning of 876-25 analyzer. Replacing the EPROM chip with a chip containing a new or an updated program changes the way the analyzer functions. The EPROM chip is programmed by the manufacturer.

Free Available Chlorine
The hypochlorous acid form of chlorine; HOCl.

Hysteresis
The reading at which an alarm is turned on is not the same reading at which the alarm is turned off again. This phenomenon is referred to as the hysteresis.

LED
Light Emitting Diode. LEDs are used as on/off indicators on the front panel of the 876-25.

Menu
The series of prompts which determine the layout of the program used by the analyzer.

Microprocessor
An integrated circuit (chip) which executes the program on the EPROM chip and controls all the input/output functions.

Nernst Equation
Equation which relates the voltage signal produced by the electrodes to the pH of the sample. The equation is temperature dependent.

NC, Normally Closed

NO, Normally Open.

Normally Closed
Each of the alarm contacts can be wired and configured as normally open or normally closed. A circuit which is wired normally closed will be closed, ie. the external device wired to it is turned on, when the analyzer is not powered.

Normally Open
A circuit which is wired normally open will be open, ie. the external device wired to it is turned off, when the analyzer is not powered.

On/off Control
Control response in which the contact is either fully on or fully off.

ppm, Parts per Million.
1 ppm = 1 mg/L. Unit of concentration for chlorine measurement.

RAM
Random Access Memory. Memory in a RAM chip can be both written to and read from. The contents of RAM will disappear as soon as the RAM chip loses power. The RAM chip has a battery backup device which preserves the contents of the RAM chip for a considerable time even if the analyzer is turned off. All settings are stored in RAM.

TC, Temperature Compensator.

Temperature Compensation
Correction for the influence of temperature on the sensing electrode. The analyzer reads out concentration as if the process were at 25 °C, regardless of actual solution temperature.

Total Free Available Chlorine
Sum of the hypochlorous acid (HOCl) and hypochlorite ion (OCl^-) forms of chlorine.

CONFIGURATION OF PROGRAM

The 876 analyzer has been designed with ease-of-use in mind. In most cases the analyzer has been configured to ordered specifications at the factory and no configuration of the analyzer is necessary. However, several hardware options are available and if they are changed the program configuration settings need to be set accordingly for the program to function properly. Other program adjustments which are normally made infrequently or when installing the analyzer are located in the configuration menu.

Normally Open or Normally Closed Alarm Contacts

The 876 program assumes the alarm contacts are wired normally open. A normally open alarm contact will be open (inactive) if there is no alarm condition and will be closed (active) when there is an alarm condition. If the program configuration and the wiring for each alarm do not match then the incorrectly configured alarm contact will generate an alarm when there is no alarm condition and vice versa.

Initializing All Program Settings

Occasionally, it may be desirable to reinitialize all of the program's settings to bring them back to default. Executing the initialization procedure will cause the analyzer to reset all the program variables, settings, preferences, and input calibrations to factory default and then proceed with the normal startup display.

The initialization procedure is not to be used unless you are absolutely sure that you want to restore the analyzer to factory default configuration.

After the analyzer program has been initialized, you will need to re-enter the output signal settings, alarm settings, as well as the program configuration if it was different from the factory default settings.

Select [CONF] [init] [ALL] [do] from the menu. The display will flash [do]. Nothing will happen if you press *SAMPLE* or *CANCEL*. The analyzer will re-initialize only if you press *ENTER*. The analyzer will then go through it's start up sequence.

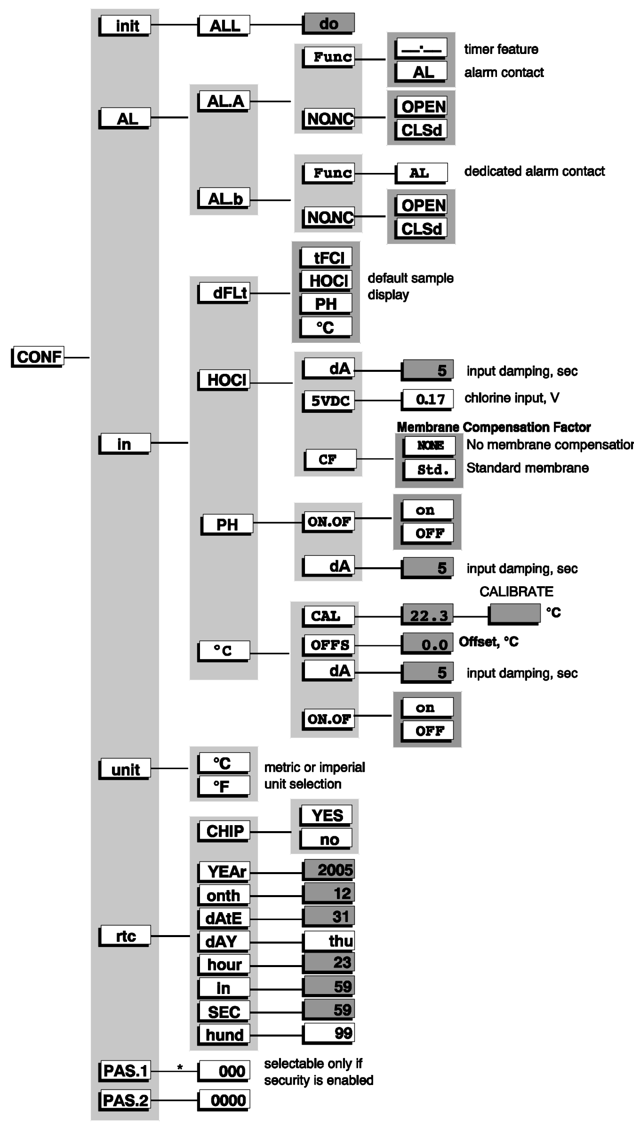


Illustration 36: Configuration menu

Metric or Imperial Units

By default the analyzer will use metric units. This means that temperature will be displayed using degrees Celsius and that the prompt for the temperature input will be [°C]. The analyzer can also be made to use imperial units as the preferred unit. Using imperial units, temperature will be displayed using degrees Fahrenheit in the sample menu and the prompt for the temperature input will be [°F] instead of [°C] throughout the program.

For practical reasons, the temperature input is identified as [°C] throughout this instruction manual and in the menus.

To select imperial units for the analyzer, select [unit] from the configuration menu, then go into edit mode and change the [°C] prompt to [°F].

Input Damping

The chlorine, pH and temperature measurements can be damped to deal with rapidly-varying or noisy signals. Damping range is selectable between 3 s to 99 s. With 0 seconds, each reading is used to directly update the display and 4 mA to 20 mA output. The factory default of 5 seconds adds the next 4 seconds of readings to the first and divides by five; this gives fast response. Selecting 99 seconds provides a smooth damping out of turbulent readings. Any selection between 3 s and 99 s can be made.

Select [CONF] [in] from the menu. Using *Up* or *Down* arrow key find the desired input and press *SELECT*. Using *Up* or *Down* arrow key find [dA] and press *SELECT*. Press *ENTER* to get into edit mode and change the damping value to the new value. Press *ENTER* to accept the change and leave edit mode.

Real-Time Clock

All IC CONTROLS analyzers have an internal clock used for date/time stamping of system events and the internal data log. On power outage, the clock stops, then it continues where it left off when power returns.

When the 876-25 is purchased with option -34, a real-time clock will maintain the correct time and date even with the power turned off. To check if your analyzer has a real-time clock, select [CONF] [rtc] [CHIP] from the menu. If the display shows [YES], then there is a real-time clock. If the display shows [no] you can still set the date/time clock, but the time and date will need to be adjusted each time the analyzer loses power.

To set the real-time clock, select [CONF] [rtc] from the menu. Set the year, month, day (of the month), hour, minute, and second.

Electronic Calibration of Inputs

Adjustments to the input circuits of chlorine, pH and temperature can be made both electronically and by making software adjustments.

The program adjustments are made using the configuration section of the menu, ie. by selecting [CONF] [in] and then the appropriate input from the menu. The procedures are described in detail in the *Electronic Hardware Alignment* section.

OUTPUT SIGNALS

Two assignable 4 mA to 20 mA output channels are provided. The user may configure the analyzer to determine which input signal will be transmitted by each 4 mA to 20 mA output channel. Each output channel can be independently configured to transmit a chlorine, pH or temperature signal.

The output channels function independent of each other. Each output channel has a separate on/off switch and adjustable low and high span (or scale) adjustments. This makes it possible, for example, to transmit both HOCl and tFCl signals, each using separate high and low adjustments.

To adjust the output span or output window for chlorine, pH or temperature signals, set [LO] to correspond to the low end of the scale or 4 mA output, and set [HI] to correspond to the high end of the scale or 20 mA output. The analyzer will automatically scale the output according to the new settings.

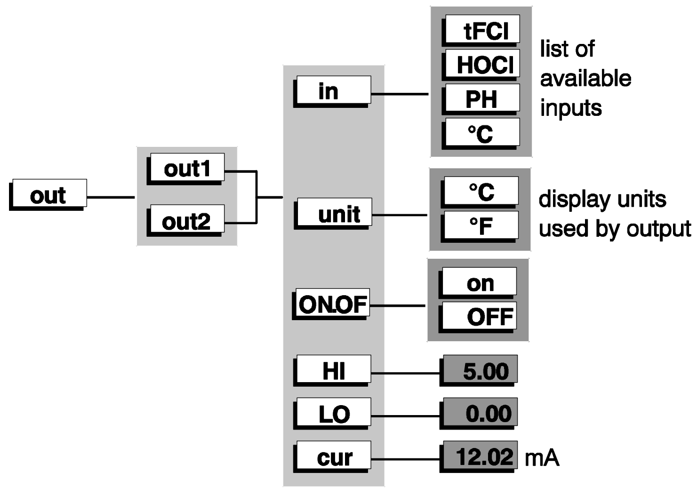


Illustration 37: Output menu

Reversing the 4 mA to 20 mA Output

The low scale setting will normally be lower than the high scale setting. It is possible to reverse the output or "flip the window" by reversing the settings of the low and high scale.

Simulated 4 mA to 20 mA Output

Select [cur] from the menu to display the output current in mA that is presently being transmitted. The display will be updated as the output signal changes based on the input signal and the program settings. From here, one can watch the output respond to the change in the input signal. This is useful for verifying program settings and for testing the hardware calibration.

In addition, the 876-25 output can be used to calibrate downstream receivers such as 4 mA to 20 mA recorders or data acquisition systems. To simulate a different 4 mA to 20 mA output signal press *ENTER* to access edit mode. Edit the displayed mA value to display the desired output needed for testing the output signal. Press *ENTER* to select the displayed value. The output signal will be adjusted to put out the desired current. This process can be repeated as often as necessary.

The output signal is held at the displayed level until the program leaves this part of the menu.

Units for Outputs

The output menu will be using different units for its settings, depending on the input selected. Select [unit] from the output menu to display the units in use for this output.

ALARM FUNCTIONS

Two alarms, alarm A and alarm B, are a standard feature. Each alarm has an alarm contact associated with it which can be used for remote alarm indication or for control functions. The two alarms function independently of each other. Either alarm can independently monitor any of the inputs.

Each alarm features an adjustable set-point, user-selectable alarm type, and adjustable differential (also called hysteresis). The alarm types which are available are “no chlorine”, high, low, deviation, and fault. Alarms can be set anywhere between 0 ppm and 2 ppm for HOCl, 0 ppm to 5 ppm for tFCl, 0 pH to 14 pH for pH and -5 °C to 105 °C for temperature.

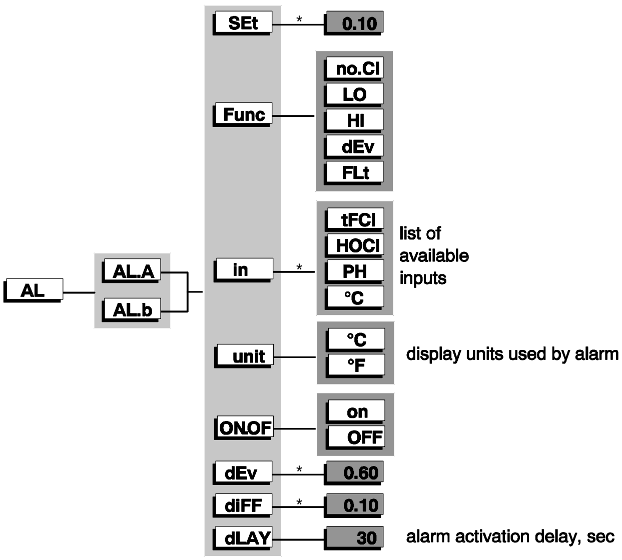


Illustration 38: Alarm menu

Use of Relay Contacts

By default, the relay contacts will be used to indicate alarm conditions. Alarm conditions are indicated using both the LED and the relay contact. This usage of the relay contacts is selected by setting [CONF] [AL] [AL.A] [FUNC] and [CONF] [AL] [AL.b] [FUNC] to [AL]. If some other use is selected for the relay contacts then the alarm cannot simultaneously use the contact; however, the alarm function continues using the LED, display messages and serial communication.

Alarm Indication

The A and B LEDs on the front panel show the current state of each alarm and alarm contact. In addition, an alarm condition for an input will cause the sample display for that input to alternate with the alarm function, [no.Cl], [LO], [HI], [dEv], or [FLt]. An LED that is blinking or on shows that the alarm has an alarm condition. The status of the alarm contact can also be determined at a glance; the corresponding alarm contact is activated when the LED is on and is deactivated while the LED is blinking or off. Note that the alarm LED will blink while the alarm is in MANUAL because this also deactivates the alarm contacts.

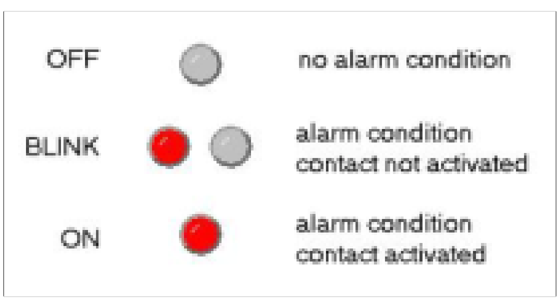


Illustration 39: Alarm status indication, alarm LEDs

Each alarm will generate a caution number in the error menu. Refer to *Caution Messages for Alarms* in the *Error Messages* section for the meaning of each alarm caution. The alarm cautions will not cause the error LED to come on because the error LED only comes on if there are any errors. To view alarm caution(s) using the error menu, select [Err] from the main menu, then use the *Up* or *Down* arrow key to scroll through the list of errors and cautions, if any.

Each alarm situation also causes an event tag to be written into an internal log which can be accessed using the IC Net Intelligent Access Program. The IC Net program uses the analyzer's serial communication port to read and display this information.

Manual Alarm Override

For normal alarm operation the alarms are said to operate in auto-mode. If the operator wishes to intervene and switch off the alarm contacts temporarily while attending to a problem, the alarms can be switched to manual override using the *MANUAL* key.

In AUTO mode: the green AUTO LED is on and the analyzer alarms will activate and deactivate the relay contact as programmed. Press the *MANUAL* key to temporarily deactivate the alarm contacts.

In MANUAL mode: the green AUTO LED will blink. The relay contacts are deactivated, but the alarm LEDs continue to indicate alarm condition(s). Press the *AUTO* key to return to AUTO mode immediately and reactivate the relays. If no key is pressed for 15 minutes, the 15-minute timeout will return the alarms to AUTO mode.

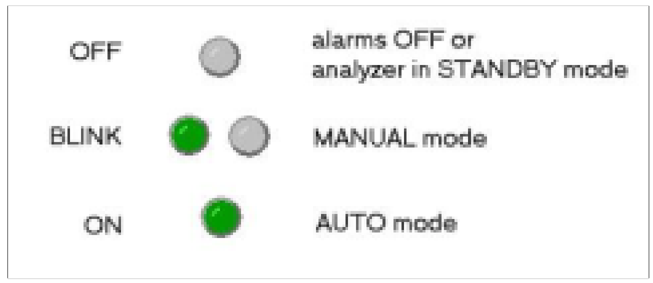


Illustration 40: Alarm override status, AUTO LED

Delayed Relay Activation

Alarm relay activation, by default, is immediate upon alarm condition. Alarm relay activation may be delayed. Activation delay gives the operator a chance to correct alarm situations before the relay contacts activate, or can eliminate alarms based on temporary or spurious changes in the process.

The delay time is programmable by the operator. To change or view the delay time, select [dLAY] from the alarm menu. The default value of 0 seconds is for immediate contact activation. The delay time can be set from 0 s to 9999 s.

Unit Selection

The alarm module will be using different units for it's settings depending on the input selected. Select [unit] from the alarm menu to display the units in use for this alarm. The [unit] setting affects the set-point, differential, and deviation settings for the alarm.

The temperature input will use different units depending on whether metric or imperial units are selected. For temperature, the unit selection can be viewed only. The choice between metric or imperial units is made in the configuration menu. Refer to the *Configuration of Program* section for further details.

Wiring and NO/NC Contacts

The alarm contacts for alarms A and B may be wired as normally open or normally closed. By default, the analyzer assumes the alarm contacts are wired normally open. A normally open alarm contact will be inactive if there is no alarm condition and will be active when there is an alarm condition. If the program configuration and the wiring for each alarm do not match then the incorrectly configured alarm contact will generate an alarm when there is no alarm condition and vice versa.

High or Low Alarm

A high alarm is set when the value of the chlorine, pH or temperature rises above the set-point and is cleared when that value drops to below the set-point minus the differential (refer to Illustration 41). A low alarm is set when the value of the chlorine, pH or temperature drops below the set-point and is cleared when that value rises to above the set-point plus the differential (refer to Illustration 42). The differential has the effect of setting the sensitivity of the alarm. The differential provides a digital equivalent of a hysteresis.

A two-stage alarm can be implemented by choosing the same alarm function, ie. high or low alarm, for both alarms, but selecting different set-points.

Example:
The HOCl of a critical process may not drop to below 0.5 ppm. Use alarm A as a low alarm set at 0.5 ppm and use alarm B as an advance warning device by configuring it as a low alarm set at 0.75 ppm. When alarm B is activated there is still time left to take corrective action.

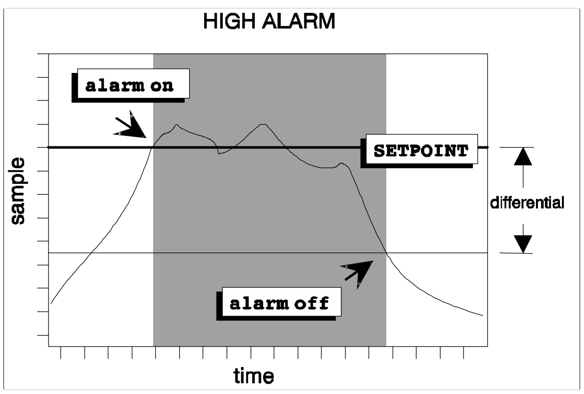


Illustration 41: High alarm

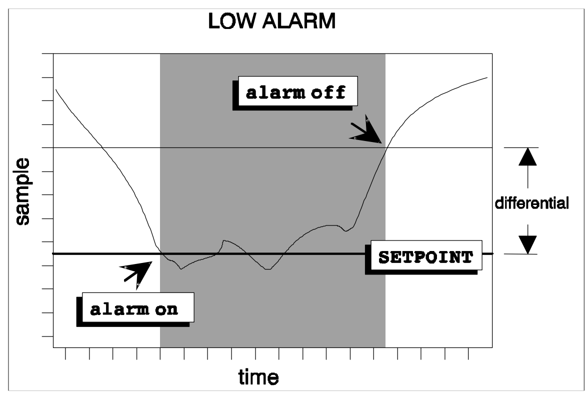


Illustration 42: Low alarm

Deviation Alarm

A deviation alarm is practical when the process is expected to stay within a certain range. An alarm will be set if the input deviates too far from a set-point. Note that the [dEv] frame only shows up in the menu after the alarm function has been changed to deviation alarm; it would have no effect for a high, low, or fault alarm.

Example*:*
If the total free chlorine concentration is expected to stay between 0.2 ppm and 1.0 ppm, then we would set [in] to [tFCl], [Func] to [dEv], [SEt] to 0.6, and [dEv] to 0.4. Effectively, a high alarm at 1.0 ppm and a low alarm at 0.2 ppm has been set.

The differential setting will continue to function as for high and low alarms.

Fault Alarm

A fault alarm for an input will be set when anything goes wrong with that input. Something is wrong with an input if the input is off-scale or an unacknowledged error message exists for that input. Caution messages do not cause a fault alarm.

To use an alarm as a fault alarm, select [FUNC] from the alarm menu, then select [Flt]. To enable the alarm, make sure the on/off switch is set to [on]. Also, set the input in the alarm menu to the desired input, either chlorine, pH or temperature.

The set-point and differential for the alarm have no effect when the alarm is used as a fault alarm.

Using Alarms for On/Off Control

The alarms can also be used for process control; the alarm contacts will then function as on/off signals for switches controlling a valve, pump, or motor. The set-point determines the control point of the system and the setting of the differential controls the amount of corrective action before a controlled shut-off occurs.

TROUBLESHOOTING

Analyzer: Electronic Hardware Alignment

Devices referred to in the following descriptions are shown on component location drawings D5030269 and D5980176. Proper field wiring for hookup is shown on drawing D5040276. These instructions assume 115/230 VAC power is hooked up, the calibration of input electronics are operable, and field wiring is in place.

Alignment of Chlorine Detection Circuit

1. Set up a precision multimeter, Fluke 8051A or equivalent, to read VDC.
2. Use the “CL2” sensor connection, TB201-1, and “COM” sensor, TB200-3, as common. Refer to wiring diagram.
3. Set the chlorine efficiency constant to 100% by selecting [tFCl] [EFF] from the menu and editing the value to read 100.0%.
4. Adjust the electronic standardize with blue trimpot VR200, located mid-board above the terminal block marked D.O., see drawing D5020269. Adjust the trimpot to a reading of 2.50 V at TP200 while inputting 0.250 VDC through a 1 MΩ 1% resistor. 0.250 VDC simulates 1.0 ppm HOCl at approximately 100% efficiency under above conditions.

Calibration of Temperature Input

The temperature input can be adjusted both by making electronic adjustments and/or by having the program compensate for differences in offset.

By default the analyzer is shipped with a 1.07 kΩ 1% resistor across the TC terminals. A 1.07 kΩ resistor across the TC terminals will simulate a temperature of approximately 18 °C or 65 °F.

<u>Software Calibration</u>

To do a software calibration of the temperature input, the correct temperature needs to be known.

1. Select [CONF] [in] [°C] [CAL] from the menu. The actual temperature as measured by the temperature sensor will be shown. Edit the displayed value to the known, correct temperature. Press *ENTER* to leave edit mode, then *SELECT* to start the calibration.
2. The current temperature will be shown using a flashing display. When it looks like the input is stable, press *ENTER* to set the new temperature. The software offset for the temperature input will be adjusted automatically.
3. The calculated offset in degrees Celsius can be viewed by selecting [CONF] [in] [°C] [OFFS] from the menu. Whenever the hardware alignment is ‘correct’, the offset will be 0.0. The displayed offset can be edited.

Adjusting Electronic Calibration

1. Remove any offset calculated by a previous software calibration of the temperature input. Select [CONF] [in] [°C] [OFFS] from the menu and edit the offset to read 0.0.
2. Set up a precision multimeter, Fluke 8051A or equivalent, to read VDC.
3. Use TB200, terminal 3, as common. See wiring diagram. Place a 1000 Ω 1% resistor across T+ and T-. Adjust blue trimpot VR202, located at the top-left side of TB201, for a reading of 0.225 V at TP202. Refer to wiring diagram and drawing D5030269 for component locations.
4. Place a 1,385 Ω 1% resistor across T+ and T-. Adjust blue trimpot VR203, located at top-right side of U201, for a reading of 4.80 V at TP202. Refer to drawing D5030269 for component locations.
5. Close case and press *SAMPLE* key followed by the *Down* arrow key to display the temperature reading.
6. Re-insert the 1000 Ω 1% resistor and adjust VR202 until the display reads 0.0 ± 0.1 °C.
7. Re-insert the 1,385 Ω 1% resistor and adjust VR203 until the display reads 100.0 ±0.1 °C.

Calibration of pH Input

Input for measurement circuit zero, 0.00 V, at high impedance BNC connector, normally found on preamp; refer to drawing D5030269, 876 main board component locations. Measured voltage at TP201 (Pin 1 of U201) should be 2.50 VDC. Adjust voltage using blue trimpot VR204.

Note: *There is no span adjustment because the chemical calibration always varies it to suit the electrode*.

Calibration of 4 mA to 20 mA Outputs

Use one of the following two approaches to get the analyzer to output the desired current level, and then make electronic adjustments to calibrate the output.

Approach 1: Simulated 4 mA to 20 mA Output (Self Calibration)

1. Select [cur] from the output 1 menu to display the present output current in mA. The display will be updated as the output current.
2. To simulate a different 4 mA to 20 mA output signal, press *ENTER* to enter edit mode. Use the arrow keys to display the desired output signal. Press *ENTER* to select the displayed value. The output signal will be adjusted to put out the desired current. This process can be repeated as often as necessary to output different signal levels.
3. The output signal is held at the displayed level until the program leaves this menu selection. Make calibration adjustments while the analyzer shows the output at 20.00 mA.
4. Repeat the above steps for output 2.

Approach 2: Use Voltage Source to Adjust Input

This faster calibration approach requires a voltage source for the input.

1. To calibrate output 1, set [in] = [°C], input a low enough signal to cause analyzer to indicate [- Err]; the analyzer will output 4.00 mA. Reverse the polarity or input a high enough signal to cause the analyzer to indicate [+ Err]; analyzer will output 20.00 mA.
2. Repeat step 1 for output 2.

Tip: *Both outputs can be simultaneously calibrated if you set [in] = [°C] for both inputs.*

Adjusting Electronic Calibration

1. Outputs are isolated from main circuit, therefore, measurements are made with common at the output 2 terminal, TB304.
2. Measure output 1 ‘zero’ at TP301 (pin 8 of U304), while output 1 is outputting 4.00 mA. Reading should be between -0.870 V and -1.250 V. Adjust #2 voltage with VR300.
3. Change analyzer output to 20.00 mA, switch meter to mA and measure + Terminal (+ terminal of O/P 1) and adjust VR301 so that the current reads 20.00 mA. Return analyzer output to 4.00 mA and trim actual output to 4.00 mA using VR300. Check again at 20.00 mA and repeat adjustments until satisfied.
4. Measure output 2 zero at TP300 (pin 7 of U304), while output 2 is outputting 4.00 mA. The test point should read between -0.870 V and -1.250 V. Adjust #2 ‘zero’ voltage with VR302.
5. Change output at output 2 to 20.00 mA, switch meter to mA at TB304, + terminal of output 2, and adjust VR303 (span pot) until the current reads 20.00 mA.
   Note: *Zero and span are very wide range adjustments which show small interactions. Recheck zero and span to confirm good calibration.*
6. If so desired, all software settings can be returned to factory default condition by performing a reinitialization. Refer to heading *Initializing All Program Settings* in *Configuration of Program* section.

Testing Relay Outputs

1. Relay output operation can be verified by testing for contact closure or continuity at each relay. To activate a relay, select [CONF] [NO.NC] [AL.A] from the menu. Press *ENTER* to go into edit mode, then press the *Up* or *Down* arrow key to change the normally open/normally closed configuration from open to closed. Press *ENTER* again to accept the new value. A closed contact should open, an open contact should close.
2. Repeat step 1 for for the Alarm B contact.
3. If so desired, all software settings can be returned to factory default condition by following the procedure in *Re-initializing All Settings* in the *Configuration of Program* section.

Chlorine Sensor

Slow Response — typically due to excessive sample line length and low flow, thus producing long sample transport lags. Resolve by adding a fast-flow loop with the sensor in a short side stream, or by shortening the line. Slow response can also be caused by growth of biologicals in the sample line. In this case, the problem may be alleviated by changing the take-off point.

Readings consistently low or spike low — characteristic of wiring problems between the analyzer and the chlorine sensor; an open circuit in the field wiring will result in zero cell current and a very low reading. Review the installation instructions.

Readings gradually falling — the analyzer can no longer be calibrated properly. This problem is typical of sludge/slime deposits on the face of the chlorine sensor. The sensor will need to be cleaned. Refer to the *Monthly Maintenance* and/or *Semi-Annual Maintenance* procedure in this manual.

Readings trend higher — this problem is typical of pressure gradually stretching the chlorine sensor membrane which is getting thinner. The membrane will soon fail. Correct by lowering pressure at the sensor. Change membrane if required.

pH Sensor

IC CONTROLS manufactures a portable pH analyzer and pH calibrator, model 659, for this purpose. The calibrator can be used to prove the portable pH analyzer before use, or it can be used to prove the process pH analyzer, in this case the 876, where a problem has been exhibited.

Before testing the pH sensor, be sure the test analyzer is known to be good.

FIRST: Inspect electrodes and if dirty or scaled:

- Clean with a soft cloth.
- Acid clean to remove scale as per *Chemical Clean* procedure.

SECOND: Run buffer tests in (but do not adjust analyzer):

- pH 7 buffer; write down reading and response time
- pH 4 buffer; write down reading and response time

Slow response? Clean again or acid clean overnight in electrode wash solution, P/N A1100091. Make sure that after cleaning, response is not longer than 3 minutes.

REFERENCE: If pH 7 reads between 6 pH and 8 pH then the reference is good. If pH reading is outside pH 6 or pH 8, then the reference is poor or has failed.

pH GLASS: Subtract pH 4 reading from pH 7 reading.

- if result is 2.5 to 3, the glass is good.
- if result is less than 2.5, then pH electrode is failing and should be replaced.

Less responsive pH electrodes can sometimes be regenerated with P/N A1100092, electrode renew solution. Refer to *Restoring Electrode Response.*

THIRD: If pH sensor passes the above tests, then it is good.

Place electrode back in the loop and then run a 2 buffer calibration following the instructions in this manual.

FOURTH: If the sensor fails tests:

- Replace the pH sensor.

Troubleshooting Tips for pH

Reading spike – characteristic of bubbles in the sample line passing through the sensor or sticking to the pH sensor. Also characteristic of pickup from interference pulses generated from AC lines, when AC loads go off-line.

Readings gradually drifting away – the pH sensor can no longer be calibrated. This problem is typical of scale or sludge/slime deposits on the pH glass. The sensor may need to be cleaned.

Readings at maximum – under all conditions.

Either the sensor is in air or there is a problem with the wiring/analyzer setup. Test for shorts by disconnecting BNC and checking impedance between center pin and outside housing with sensor in air. Insulation value should exceed 100 MΩ.

If the sensor is OK, use the model 659 portable calibrator/analyzer to test the preamp, wiring and the analyzer. If the problem persists with the 659 in place then it is an analyzer problem.

If the sensor tests as still good, and the analyzer and wiring works with the model 659, but the "+ERR" or over-scale still occur when the analyzer and sensor are hooked up and placed in service, then the most likely cause is a ground loop short forming, not actually a pH sensor problem. Refer to the model 659 user manual troubleshooting procedures to resolve this pH loop, plant site, interaction problem.

The above symptoms cover most difficulties associated with pH sensors. The key to isolating problems in the pH sensor or analyzer is being able to separate the two.

Restoring Electrode Response

Used electrodes which are mechanically intact but low efficiency or slow responding, can often be restored to full response by one of the following procedures:

1) **Scale deposits:**
   Dissolve the deposit by immersion of the electrode tip, overnight (or over weekend), in electrode wash solution, P/N A1100091, followed by rinse in tap water. Soak in electrode storage solution, P/N A1100090 for 1 to 2 hours.
   Difficult cases: Repeat substituting gentle scale remover, P/N A1100093, then 15 minute rinse.

2) **Oil or grease films:**
   Wash electrode tip with detergent and water. If film is known to be soluble in a particular organic solvent, wash with this solvent. Rinse electrode tip with tap water. Let sit in demin water, P/N A1100015, for 2 to 4 hours, followed by 2 to 4 hours in electrode storage solution, P/N A1100090.
   Difficult cases: Repeat using wash in sodium hypochlorite (Javex Bleach) in water solution, adjusted to pH 6.5 ± 0.5 using vinegar or acid.

3) **Plugged or dry reference junction:**
   Remove the contaminant with one of the above procedures, then soak in electrode storage solution, P/N A1100090 for 24 hours to one week.
   Difficult cases: Repeat but heat almost to boiling for ½ hour first, then soak in electrode storage solution, P/N A1100090 for 24 hours to one week.

4) **Biological growths:**
   Wash electrode tip with detergent and water.
   Difficult cases: Wash with Sodium hypochlorite (Javex Bleach) in water solution, adjusted to pH 6.5 ± 0.5 using vinegar or acid. Use rubber gloves, and wash until deposits fall off or turn white. Rinse tip with tap water. Let sit in demin water, P/N A1100015 for 2 to 4 hours, then 2 to 4 hours in electrode storage solution, P/N A1100090.

5) **Clean, but slow and with less than 85% efficiency:**
   Wash electrode tip with electrode renew solution, P/N A1100092, for 15 minutes. Rinse electrode tip using tap water for 15 minutes. Let sit in demin water, P/N A1100015, for 2 to 4 hours, followed by 2 to 4 hours in electrode storage solution, P/N A1100090.

Note: *If none of the above procedures succeed in restoring electrode response, it is near the end of the useful life of that sensor and should be replaced.*

APPENDIX A — Enabling Security

The analyzer has a built-in password protection system. This security system is disabled by default and does not need to be enabled if no password protection is necessary. If you choose not to enable the password protection system then the user will have unrestricted access to all analyzer settings available through the menu as described in this manual.

Having security disabled gives the user the same access to the program as being at access-level 2 at all times.

With security enabled anyone can view settings anywhere in the program. When you do not have proper access rights, the program will display [PASS] for 2 seconds, indicating that a proper password must be entered before being allowed to proceed.

This appendix contains instructions for setting passwords in the configuration section of the menu. Daily usage of the analyzer by the operator does not require knowledge of setting passwords in the configuration section since all passwords are entered by selecting [PASS] directly from the main menu.

Access-level	***Description***
0	View only access to all settings
1	Access to all settings except for configuration menu. **Usage:** operator access, no changes can be made to configuration and passwords cannot be changed.
2	Access to all settings. This gives the same program access as when password security is not enabled. Passwords can be changed. **Usage:** installation, management.

Table 1: Security access levels

ENTERING A PASSWORD

With security enabled, select [PASS] from the main menu. The analyzer will display [0000]. Use the arrow keys to display your level 1 or level 2 password, then press *ENTER*. The program will display [good], followed by your access level before returning to the main menu. If an incorrect password was entered, the program displays [bAd] instead. Refer to *Password Validation* flow chart to determine how the program validates a password.

You will now have level 1 or level 2 access for as long as you are working with the analyzer. The access level will automatically be restored to level 0 after no key has been pressed for 15 minutes. This 15-minute timeout will also return to display the main sample.

It is good practice to return the analyzer to level 0 access (or level 1 access if password 1 is set to “000”) when you have finished using the analyzer. This is accomplished by selecting [PASS] from the main menu, then pressing *ENTER* with [0000] displayed.

ENABLING PASSWORD SECURITY

When security is disabled, both password 1 and password 2 are set to “0000.” Security is enabled by setting password 2 to a non-zero value.

Level 2

Select [CONF] [PAS.2] from the menu. The analyzer will display [0000]. Use the arrow keys to change the display to the desired password for level 2. You can press *SAMPLE* at any time to safely cancel password entry. Press *ENTER* to enter the password into memory and to enable password security. The analyzer program automatically returns to the configuration menu.

With only password 2 set to a non-zero value, level 2 access is required to make changes in the configuration menu but all other settings are unprotected. Effectively the user will always have at least level 1 access.

Level 1

At this point, password 1 is still "000." You may optionally enable operator access control or level 1 security by changing the level 1 password from "000" to a non-zero value. Change the password by selecting [CONF] [PAS.1] from the menu, then entering an appropriate 3-digit password.

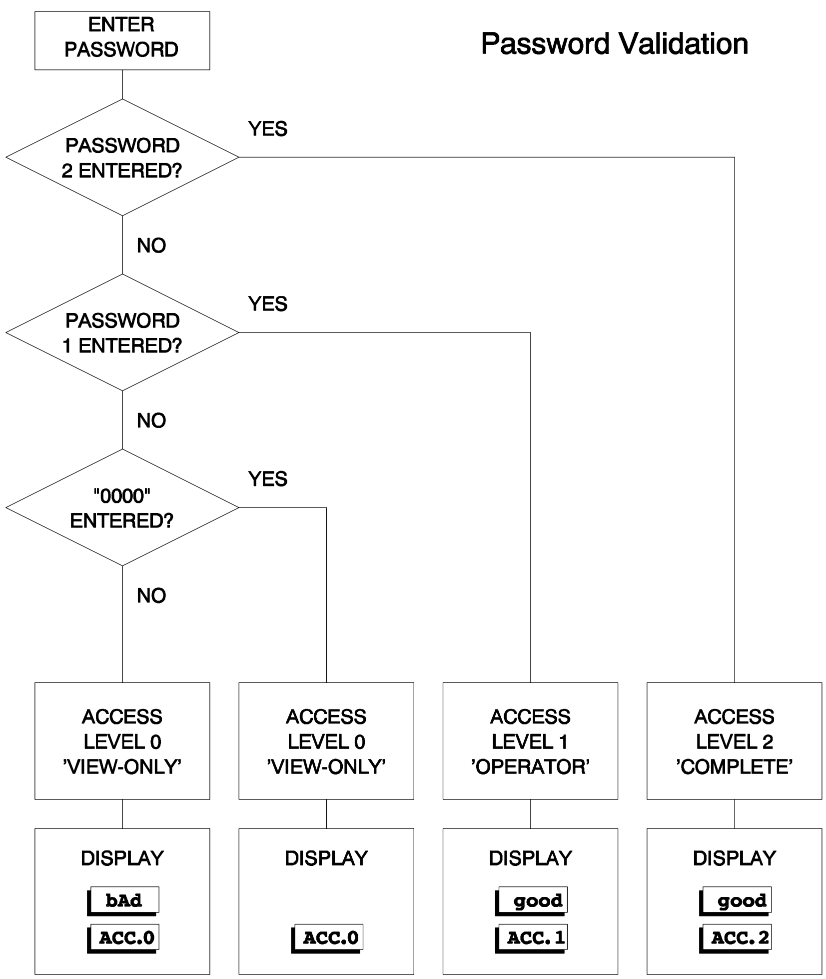
RECORDING YOUR PASSWORDS

You may want to write down the passwords you set and store them in a secure place. Once a password has been set, there is no way to redisplay it. Since passwords are set in the configuration menu, level 2 access is required to change either password. If you have forgotten the level 2 password, there is no simple way to regain access to the analyzer. Contact the factory if you find yourself locked out of the analyzer.

DISABLING PASSWORD SECURITY

Password security can be disabled by setting the level 2 password to "0000." In order to change the password you must first have level 2 access to the program.

Select [CONF] [PAS.2] from the menu, then press *ENTER* when the program displays [0000]. Both passwords 1 and 2 are set to "0000" and security is now disabled. The main menu will be changed to exclude the [PASS] frame , and the configuration menu will no longer have the [PAS.1] frame.



PASSWORD EXAMPLE - A QUICK TOUR

With security disabled, select [CONF] [PAS.2] from the menu. Set the level 2 password to “0002". Select [CONF] [PAS.1] from the menu. Set the level 1 password to ”001." Security is now enabled.

Select [PASS] from the main menu. Press *ENTER* with [0000] displayed. The analyzer will display [ACC.0] to indicate we are now at access level 0.

Try changing the output 1 low setting. Select [out] [out1] [LO] from the menu. The current value will display. Press *ENTER* to go into edit mode. The analyzer will display [PASS] for 2 seconds because we need to enter a password first. Level 1 security is needed to change this setting.

Select [PASS] from the main menu again. Change the displayed value to [0001], which is the level 1 password. Press *ENTER*. The analyzer will display [good], followed by [ACC.1], indicating that the password is valid and that we now have level 1 access.

Try changing the output 1 low setting again. You will find that this time we can go into edit mode unhindered.

Select [PASS] from the main menu again. Enter the level 2 password, which is “0002.” We are going to set the level 2 password to “0000” again to disable password security. Password 2 is found in the configuration menu and therefore requires level 2 access before it can be accessed. Select [CONF] [PAS.2] from the menu. Press *ENTER* with [0000] displayed. Both passwords are set to “0000” again and password security is disabled.

APPENDIX B — Default Settings

The following program settings are the default settings for the analyzer. New analyzers will have these settings unless the setup has already been customized for your application.

Outputs

	Output 1	**Output 2**
Input to be transmitted	tFCl	°C
Low setting	0.00	0.0
High setting	2.00	100.0
ON/OFF switch	ON	ON

Alarms

	Alarm A	**Alarm B**
Input for alarm	tFCl	tFCl
Alarm function	HI	LO
ON/OFF switch	ON	ON
Set-point	0.60 ppm	0.20 ppm
Differential	0.10 ppm	0.10 ppm
Unit	1E-6 (ppm)	1E-6 (ppm)
Delay	0 s	0 s

Global Units

Metric units: temperature in degrees Celsius, chlorine concentration in parts per million (ppm)

Alarm Contacts

Configured normally open

Security

Not enabled

pH and Temperature Compensation Method for Chlorine

Automatic TC using temperature input; automatic pH compensation using pH input

Membrane Compensation

Enabled

Timer Feature

Not enabled

APPENDIX C — Installation

Electrical

The analyzer requires 115/230 VAC power to be hooked up to TB400, found on drawing D5040276.

Connect the two alarm contacts: Alarm A contact: TB300
Alarm B contact: TB301

Connect the two isolated 4 mA to 20 mA outputs: Output 1: TB303
Output 2: TB304

Connect the inputs: Chlorine: direct connect to analyzer via 5-pin DIN connector.
pH: direct connect to analyzer via BNC connector.

Mechanical

Refer to sections entitled *Chlorine Sensor Instructions* and *pH Sensor Instructions* of this instruction manual.

Program

Refer to *Appendix B* for default settings. Prior to putting the analyzer into operation, verify the settings to ensure that they agree with the intended setup. For a more detailed description of any program setting, refer to the appropriate section of this instruction manual.

Change defaults for the alarms. Set alarm function (high, low, deviation, fault), input (chlorine, pH, temperature), differential, set-point, and on/off switch.

Change defaults for the 4 mA to 20 mA outputs. Set input, high limit, low limit, and on/off switch.

Set preference for metric/imperial units in [CONF] [unit].

Set the normally open/normally closed configuration of the alarm contacts in [CONF] [AL]. The program setting must reflect the actual NO/NC wiring.

If using automatic cleaning system, enable timer option. Select [_ . _] [ON.OF] and change setting to [ON]. For further details on the timer, refer to *Appendix D*.

If desired, install password security.

APPENDIX D — OPTION -51/-53, TIMER ELECTRODE CLEANER

Overview

A timer function is provided in the IC CONTROLS 876 program. The timer is designed to control a cleaner for the electrode. Options -51 and -53 provide the necessary cleaning accessories which can be retrofitted to the 876-25 system after initial purchase and setup. The only difference between these options is that option -51 provides a 115 V pump (P/N A2100082) and option -53 provides a 220 V pump (P/N A2100083). Options -51 and -53 do not include the cleaning solution; the user must supply cleaner. IC CONTROLS suggests using a mild hydrochloric acid (5% HCl) solution.

The timer is a program option only and does not require any modifications to be made to the analyzer electronics. The timer will use the contact for alarm A. While the timer is in use, only the contact for alarm B is available for remote alarm indication. Alarm A will continue to function, but if there is an alarm condition then only the LED will come on.

The instruction manual was written without reference to the timer function. All the changes and additions to the menu and the program are documented in this appendix.

Configuration of Alarm Contacts

Go to the configuration section of the menu; press *SAMPLE* to display measured reading. Press *SELECT* to access main menu. Use *Up* or *Down* arrow key to display [CONF].

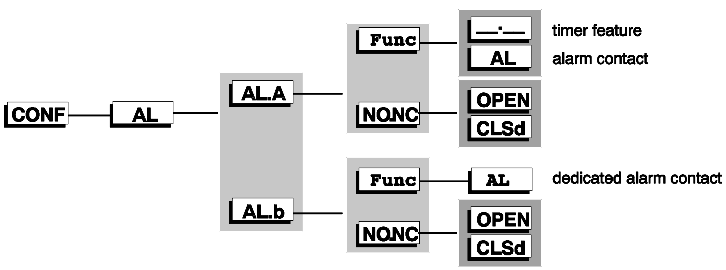


Illustration 1: Configuration of alarms menu

From the configuration menu select [AL] [AL.A] which refers to "Alarm A Contact”. Select whether the program uses the alarm A contact for alarm A or for the timer. The options are:

[AL]	alarm function
[__.__]	timer function

The normally open/normally closed configuration for the alarm A contact will be used regardless of whether the contact is used by alarm A or by the timer.

Follow the same procedure to configure "Alarm B Contact", [AL.b].

With Alarm Function:

The alarm A contact is “owned” by alarm A. The alarm A contact will be on if there is an alarm condition for alarm A otherwise the contact will be off. The LED for alarm A will show the status of the alarm and it's contact.

The timer menu is not accessible from the main menu. The [__.__] frame is not available unless the timer option is enabled.

With Timer Function:

The alarm A contact is “owned” by the timer. Alarm A will continue to function as before. The alarm A LED will come on when there is an alarm condition, however, the alarm does not have an external contact.

The timer menu is accessed by selecting [__.__] from the main menu.

Setting the Timer

The timer menu is selected from the main menu as [__.__]. The following adjustments can be made to the timer:

Prompt	*Stands for*	*Description*	*Default*
[ON.OF]	on/off switch	turn timer feature on or off	OFF
[+__.__]	on time	length of on-cycle in hour:minute	+00:01
[-__.__]	off time	length of off-cycle in hour:minute	-23:59
[HOLd]	output hold	duration of output hold in seconds	10
[StAt]	status	displays on-cycle or off-cycle and time remaining	-10:00

The on/off status is shown by the ± sign. After the timer is turned on, the contact can be turned on or off by changing the ± sign using the *Up* or *Down* arrow key.

The default setting for the timer is an off-cycle of 24 hours, followed by one minute of cleaning so that the analyzer will turn on the contact for one minute at the same time each day.

Interaction with Other Analyzer Functions

Automatic Output Hold

The 4 mA to 20 mA outputs will not change and the alarms will be off temporarily as long as the timer is in it's on-cycle. After the analyzer has completed it's on-cycle, the analyzer program will give the electrode some additional time to stabilize before updating the output levels and enabling the alarms again. The user specifies the length of the additional hold time in seconds in the [HOLd] selection of the timer menu.

Timer Interaction With Calibration

The timer will not start an on-cycle while a calibration is in progress, nor can a calibration be started while the timer is in it's on-cycle. The timer is generally connected to an electrode cleaner. The analyzer cannot clean and calibrate an electrode at the same time.

When Cleaning

During the on-cycle of the timer a calibration cannot be started. If a calibration is attempted, the analyzer will flash [+__.__] twice to show that the timer is now in it's on-cycle.

When Calibrating

If the off-cycle is completed during a calibration then the on-cycle will not start until after the calibration has finished. Also, as a safety and process-integrity feature, the timer will wait at least 5 minutes after a calibration has been completed before starting the on-cycle automatically. To avoid having the cleaning cycle start soon after a calibration, it is good practice to turn the timer off temporarily or to increase the time of the current off-cycle in the timer status selection.

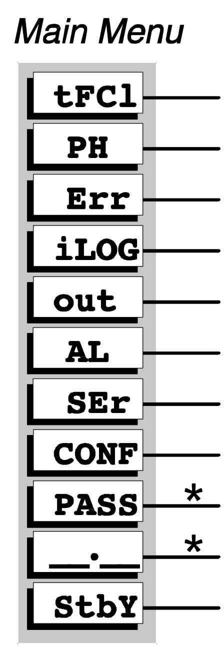


Illustration 2: Main menu with timer option enabled

Manual Operation

The timer can be operated manually by changing the timer status. Changing the timer status does not affect the programmed on-cycle and off-cycle times. To change the on/off status of the timer, the timer must be turned on. In edit mode, use the *Up* or *Down* arrow key to toggle the ± sign between + and -, then press *ENTER* to have the change go into effect.

Example:
The timer cycle is set for 24 hours; the off-cycle for 23:59 and the on-cycle for 1 minute (00:01) so that the timer will clean the electrode once a day for one minute. To turn the timer on for 2 minutes:

i. Ensure the on/off switch is set to ON.

ii. Select [StAt] from the timer menu and press *ENTER* to go into edit mode.

iii. Change the time to read 00:02 and the - sign to a + sign.

iv. Press *ENTER* to accept the changes.

The timer will now stay on for 2 minutes. When the 2-minute on-cycle is completed, the timer will start it's 23:59 off-cycle.

Timer Menu Reference

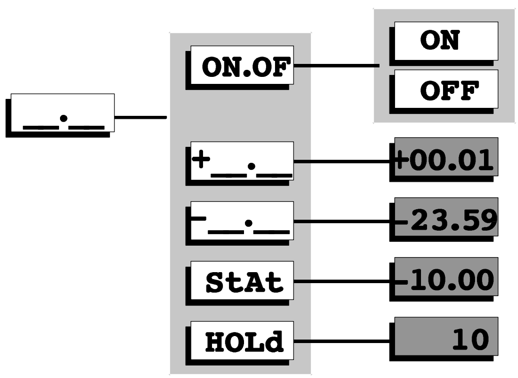


Illustration 3: Timer menu

Display Prompts Defined

[ON.OF] Turning the timer off causes the timer clock to stop updating. The alarm contact will be turned off if the timer is in it's on-cycle.

[+__.__] Set the length of the on-cycle in hours:minutes. The longest on-cycle is 99:99.

[-__.__] Set the length of the off-cycle in hours:minutes. The longest off-cycle is 99:99.

[StAt] Display the current status of the timer. The ± sign shows whether the timer is in it's on-cycle or in it's off-cycle. The timer clock is displayed in hours:minutes. Go into edit mode to change the timer status. If the timer is turned on, the ± sign can be changed to switch between on-cycle and off-cycle.

[Hold] Specify the output hold time in seconds. When the on-cycle is completed, the output hold for the 4 mA to 20 mA output signals and alarms will not be updated immediately. The additional hold time gives the electrodes time to stabilize after they have been cleaned.

Option -51/-53 Chemical Cleaning Accessories

Illustration 4: Pump sub-assembly; part identification

Pump Sub-Assembly Part Identification

A) Metering pump

B) Foot valve

C) Tubing weight

D) 4-function valve

E) ⅜ inch OD suction/ discharge tube

F) ¼ inch OD return vent-line

Cleaner Assembly Part Identification

A) ⅜ inch tube to ¼ inch tube reducing fitting

B) ⅛ inch NPT to ¼ tube elbow

C) 10 foot (3 meter) ¼ inch OD poly tube

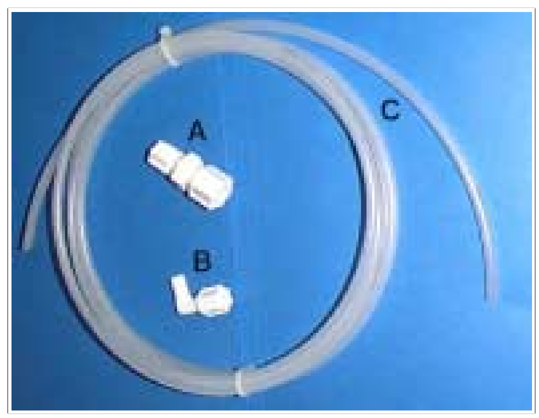


Illustration 5: Cleaner assembly; part identification

Illustration 6: Cleaner injection port location

Chemical Cleaner Injection Port

The injection port is a standard feature on the flow cell. The injection port requires a ⅛ inch NPT connection.

Cleaning Equipment Setup

Illustration 7: Chemical cleaner connection at flow cell

Chemical Cleaner Connection at the Flow Cell

A) ⅛ inch NPT to ¼ tube elbow

B) 10 foot (3 meter) ¼ inch OD poly tube

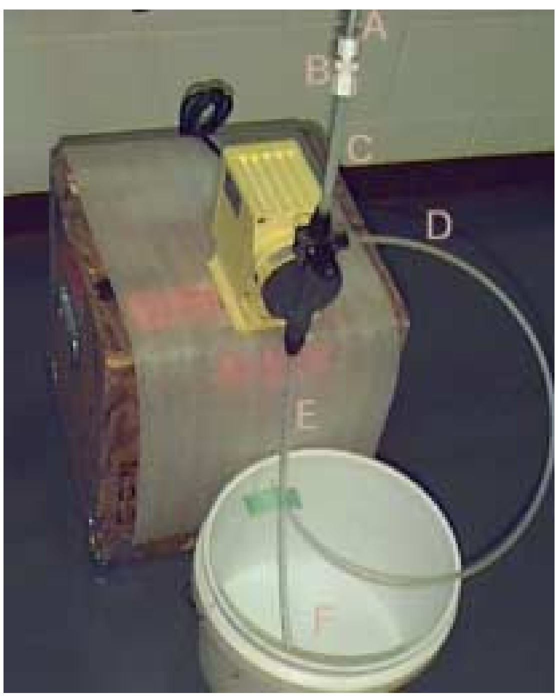


Illustration 8: Pump assembly

Pump Assembly

A) 10 foot (3 meter) ¼ inch OD poly tube

B) ⅜ inch tube to ¼ inch tube reducing fitting

C) ⅜ inch OD discharge tube

D) ¼ inch OD return vent-line

E) ⅜ inch OD suction tube

F) Chemical cleaner (supplied by user)

Note: *It is recommended that the pump be primed using demineralized water prior to using with chemical cleaner. This is to check for any leaks and for pump function.*

Chemical Cleaning Solution

The chemical cleaning solution is supplied by the user. IC CONTROLS suggests that a mild hydrochloric acid (5% HCl) solution be used.

Wiring the Pump to Analyzer

The pump is available as 115 VAC, P/N A2100082, selectable by option -51, or 220 VAC, P/N A2100083, selectable by option -53. Capacity range of pump is 0.20 to 1.0 gal/hr or (0.76 L/hr to 3.8 L/hr) at 110 psi (7.6 bar).

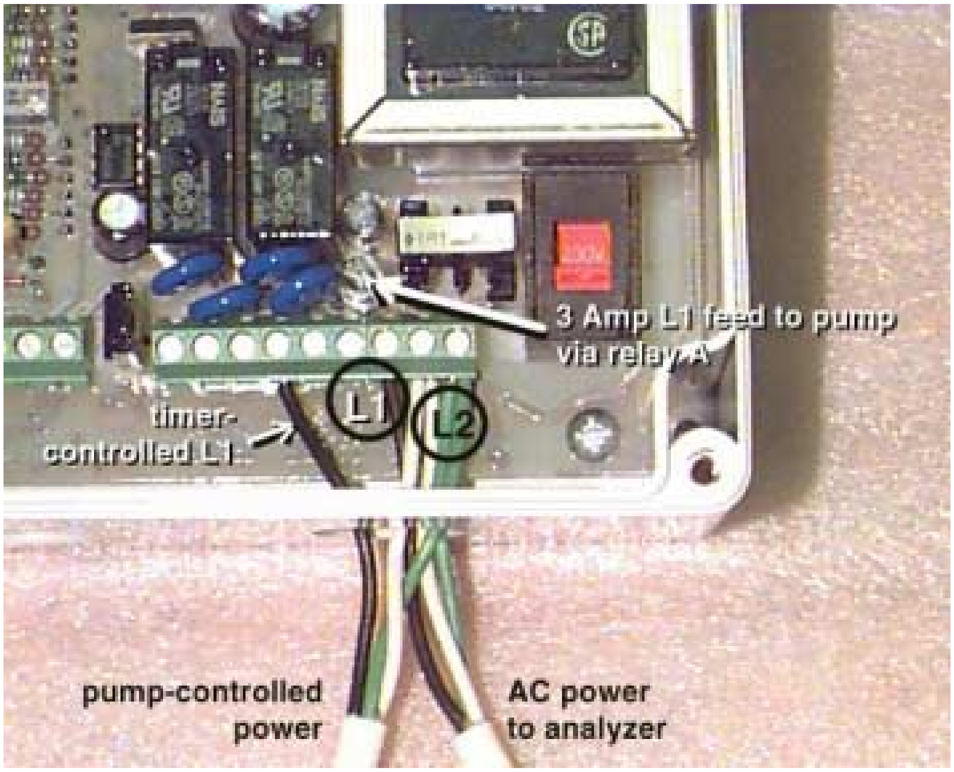


Illustration 9: Wiring the cleaner option to the analyzer

Liquid End **Sheet**

LE - 390 Series / 0.9 (IN^2)

When pumping solutions, make certain that all tubing is securely attached to the fittings. It is recommended that tubing or pipe lines be shielded to prevent possible injury in case of rupture or accidental damage. Always wear protective clothing and face shield when working on or near your metering pump.

Note: See parts list for materials of construction

A. INSTALLING INJECTION CHECK VALVE

1. The purpose of the injection check valve is to prevent backflow from the treated line.
2. A 1/2" NPT female fitting with sufficient depth will accept the injection check valve.
3. To insure correct seating of the ball inside the injection check valve, the injection check valve should be installed upwards (vertically) into bottom of the pipe.

B. CONNECTING DISCHARGE TUBING

Note: *Cut tubing to length needed for discharge line.*

1. Route tubing from the injection check valve to the metering pump, making sure it does not touch hot or sharp surfaces, or is bent so sharply that it kinks.
2. Slide the small end of the coupling nut onto tubing, then slide on the clamp ring.
3. Push tubing on the valve housing nozzle so that tubing flares out and butts up against valve housing and will not go any further.
4. Slide the clamp ring and coupling nut to the threads and engage. While pushing the tubing on to the valve housing nozzle, tighten the coupling nut by hand until tubing is held securely in place.

Excessive force will crack or distort fittings.
DO NOT USE PIPE WRENCH.

C. CONNECTING SUCTION TUBING

1. Cut suction tubing to a length so that the foot valve hangs just above the bottom of the solution container. Maximum recommended vertical suction lift is 5 ft (1.5 m).
2. Follow same procedure in connecting suction tubing to suction valve and foot valve (see **B. Connecting Discharge Tubing**).

D. PRIMING with 3FV / 4FV (see page 4 for B/4FV)

1. Connect pressure relief tubing to pressure relief port on the discharge valve.
2. Route tubing to solution reservoir and anchor with a plastic tie. Do not submerge tubing in solution.
3. Start pump. Set at 80% speed and 100% stroke.
4. Turn Pressure Relief knob (black knob) 1/4 turn. Let pump run until solution is visible through translucent return tubing.
5. Turn Pressure Relief knob back 1/4 turn. The pump is now primed.

Note:

(a) *Pump is normally self-priming if suction lift is not more than 5 ft (1.5 m), valves in the pump are wet with water (pump is shipped from factory with water in pump head) and the above steps (**D. Priming**) are followed.*

(b) *If the pump does not self prime, remove cartridge valve and pour water or solution slowly into discharge port until head is filled. Follow step **D. Priming** thereafter.*

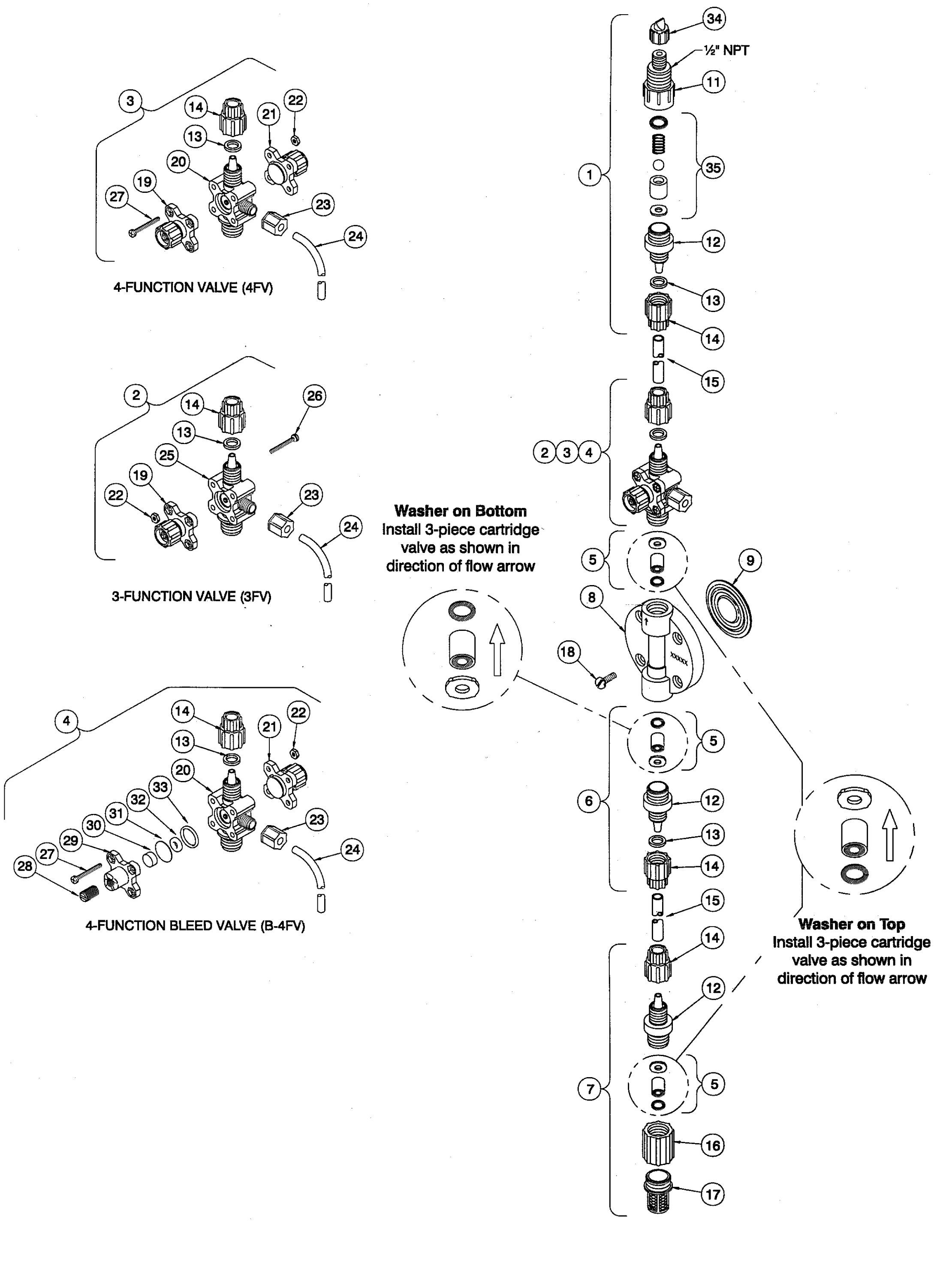
E. DEPRESSURIZING DISCHARGE LINE

1. It is possible to depressurize the discharge line and pump head without removal of tubing or loosening of fittings.

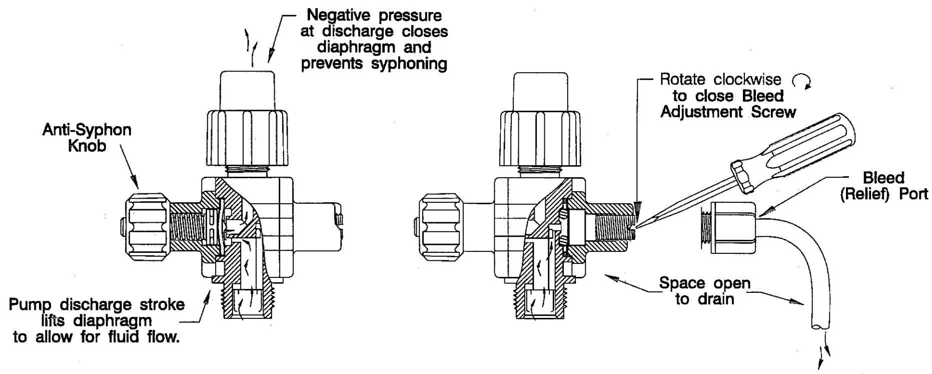
Be sure injection check valve is properly installed and is operating. If a gate valve or globe valve has been installed downstream of injection check valve, it should be closed. Be certain relief tubing from the four function valve is connected and run to solution reservoir.

2. Turn Pressure Relief knob 1/4 turn.
3. The discharge line is now depressurized.
4. If injection check valve is of higher elevation than pump head, disconnecting tubing at injection check valve end will allow air to enter and cause solution to drain back to tank.

Key No.	Part No.	Part Description	Quantity 390TI	390SI	390BI	391TI	391SI	391BI	392TI	392SI	392BI	393TI	393SI	393BI
1	37355	Inj Ck Valve, PGC™	1	1	1	1	1	1						
	37356	Inj Ck Valve, PVDF							1	1	1	1	1	1
2	36262	3FV, PGC™ 3/8	1			1								
	36266	3FV, PVDF 3/8							1			1		
3	36272	4FV, PGC™ 3/8		1			1							
	36276	4FV, PVDF 3/8								1			1	
4	36387	B4FV, PGC™ 3/8			1			1						
	36390	B4FV, PVDF 3/8									1			1
5	36308	CV .375 PGC™/Polyprel®	3	3	3	3	3	3						
	36307	CV .375 PVDF/Polyprel®							3	3	3			
	36306	CV .375 PVDF/PTFE										3	3	3
6	36351	Suction Valve, PGC™	1	1	1	1	1	1						
	36418	Suction Valve, PVDF							1	1	1			
	36354	Suction Valve, PVDF										1	1	1
7	36349	Foot Valve, PGC™	1	1	1	1	1	1						
	36416	Foot Valve, PVDF							1	1	1			
	36352	Foot Valve, PVDF										1	1	1
8	36157	Head Acrylic 0.9	1	1	1									
	36121	Head PGC™ 0.9				1	1	1						
	36122	Head PVDF 0.9							1	1	1	1	1	1
9	30917	Liquifram™ 0.9	1	1	1	1	1	1	1	1	1	1	1	1
11	37350	Inj Fitting PGC™	1	1	1	1	1	1						
	37351	Inj Fitting PVDF							1	1	1	1	1	1
12	37114	Valve Housing PGC™	3	3	3	3	3	3						
	37115	Valve Housing PVDF							3	3	3	3	3	3
13	26136	Clamp Ring	3	3	3	3	3	3	3	3	3	3	3	3
14	10299	Coupling Nut	4	4	4	4	4	4	4	4	4	4	4	4
15	10342-16	Tubing .375 P.E.	1	1	1	1	1	1	1	1	1	1	1	1
	27342-16	Tubing .375 U.V.P.E.	Black, UV resistant tubing - change "I" to "U" (for example 391SI to 391SU)											
16	36204	Foot Valve Coupling	1	1	1	1	1	1	1	1	1	1	1	1
17	10123	Strainer	1	1	1	1	1	1	1	1	1	1	1	1
18	10340	Screw, Head	4	4	4	4	4	4	4	4	4	4	4	4
19	36866	P/R Cap Asm.	1	1		1	1		1	1		1	1	
20	37226	4FV Body, PGC™		1	1		1	1						
	37227	4FV Body, PVDF								1	1		1	1
21	36280	A/S Cap Asm.		1	1		1	1		1	1		1	1
22	25628	Nut	4	4	4	4	4	4	4	4	4	4	4	4
23	25631	Coupling Nut	1	1	1	1	1	1	1	1	1	1	1	1
24	25636-10	Tubing .250 P.E.	1	1	1	1	1	1	1	1	1	1	1	1
	28636-10	Tubing .250 U.V.P.E.	Black, UV resistant tubing - change "I" to "U" (for example 391SI to 391SU)											
25	37228	3FV Body, PGC™	1			1								
	37229	3FV Body, PVDF							1			1		
26	35716	Screw, 3FV	4			4			4			4		
27	25627	Screw, 4FV		4	4		4	4		4	4		4	4
28	34876	Screw, B/4FV			1			1			1			1
29	32171	Cap			1			1			1			1
30	34868	Disc			1			1			1			1
31	32173	Diaphragm			1			1			1			1
32	32175	O-Ring			1			1			1			1
33	32176	O-Ring			1			1			1			1
34	27352	Flapper Valve	1	1	1	1	1	1	1	1	1	1	1	1
35	37349	Inj Ck Valve Kit	1	1	1	1	1	1	1	1	1	1	1	1
---	10322	Weight (not shown)	1	1	1	1	1	1	1	1	1	1	1	1


4-FUNCTION VALVE (4FV)
3-FUNCTION VALVE (3FV)
4-FUNCTION BLEED VALVE (B-4FV)
½" NPT
Washer on Bottom
Install 3-piece cartridge
valve as shown in
direction of flow arrow
Washer on Top
Install 3-piece cartridge
valve as shown in
direction of flow arrow

METHOD OF OPERATION



A. PRIMING with B/4FV (see page 1 for 3FV / 4FV)

1. Connect bleed return tubing to bleed (relief) port.
2. Route tubing to solution tank. Be sure the end of tubing is above the maximum solution level. (Do not submerge tubing in solution.)
3. Set pump at 80% speed and 100% stroke. Start pump. With screwdriver rotate bleed adjustment screw counter-clockwise two (2) full turns. When solution begins to flow through translucent bleed return tubing, the pump is primed.
4. Stop pump.

Note:

*(a) Pump is normally self-priming if suction lift is no more than 5 ft (1.5 m), valves in the pump are wet with water (pump is shipped from factory with water in pump head) and the above steps (**A1 thru A3**) are followed.*

*(b) If the pump does not self prime, remove Bleed/4-Function Valve and Discharge Cartridge, and pour water or solution slowly into discharge port until it is filled. Replace Cartridge, and follow steps **A1 thru A3** thereafter.*

B. BLEED ADJUSTMENT

1. Start pump and let pump inject solution into the discharge line.
2. Close the bleed adjustment screw by rotating it clockwise with a screwdriver.
3. Now adjust the pump stroke length and/or speed (frequency) to a range approximately 25% higher than you would normally want for the process.
4. Slowly rotate bleed adjustment screw counter-clockwise until just a small amount of solution begins to trickle down inside the bleed return tubing. A small amount of solution pumped back to the tank with each stroke of the pump will allow gas and air to escape without air or gas locking in the pump head.

C. DEPRESSURIZING DISCHARGE LINE

1. It is possible to depressurize discharge line and pump head without removal of tubing or loosening of fittings.

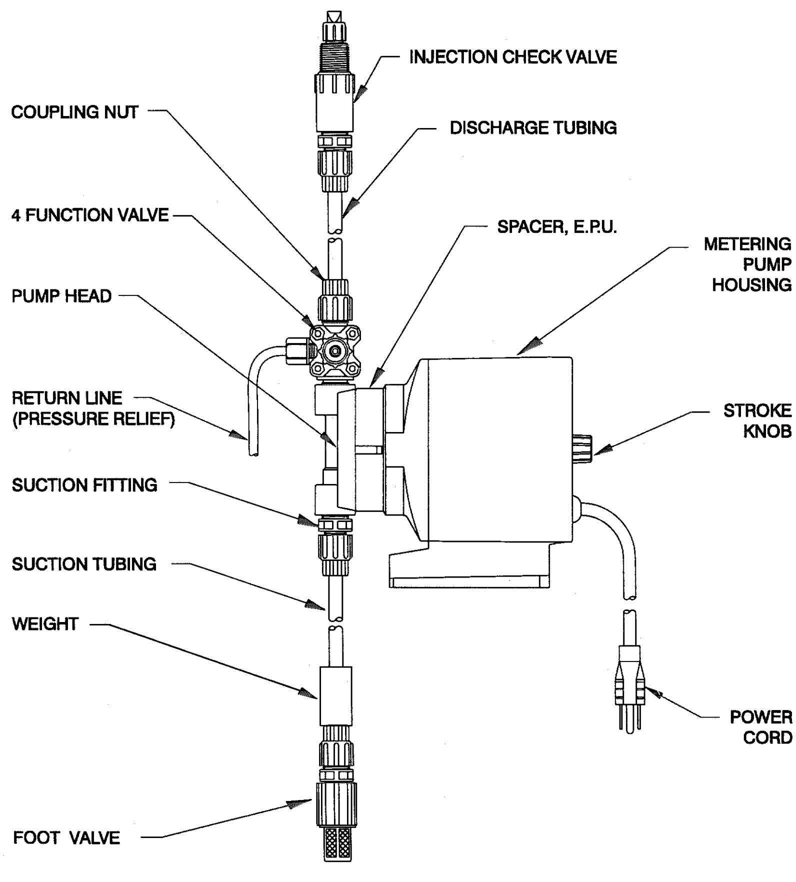
Be sure injection check valve is properly installed and is operating. If a gate valve or globe valve has been installed, downstream of injection check valve, it should be closed. Be certain bleed return tubing is connected and run to solution supply tank.

2. With a screwdriver, rotate bleed adjustment screw counter-clockwise two (2) full turns. A small amount of solution in discharge line should drain back to the supply tank.
3. The discharge line is now depressurized.
4. If injection check valve is of higher elevation than pump head, disconnecting tubing at injection check valve end will allow air to enter and cause solution to drain back to tank.

Instruction **Supplement**

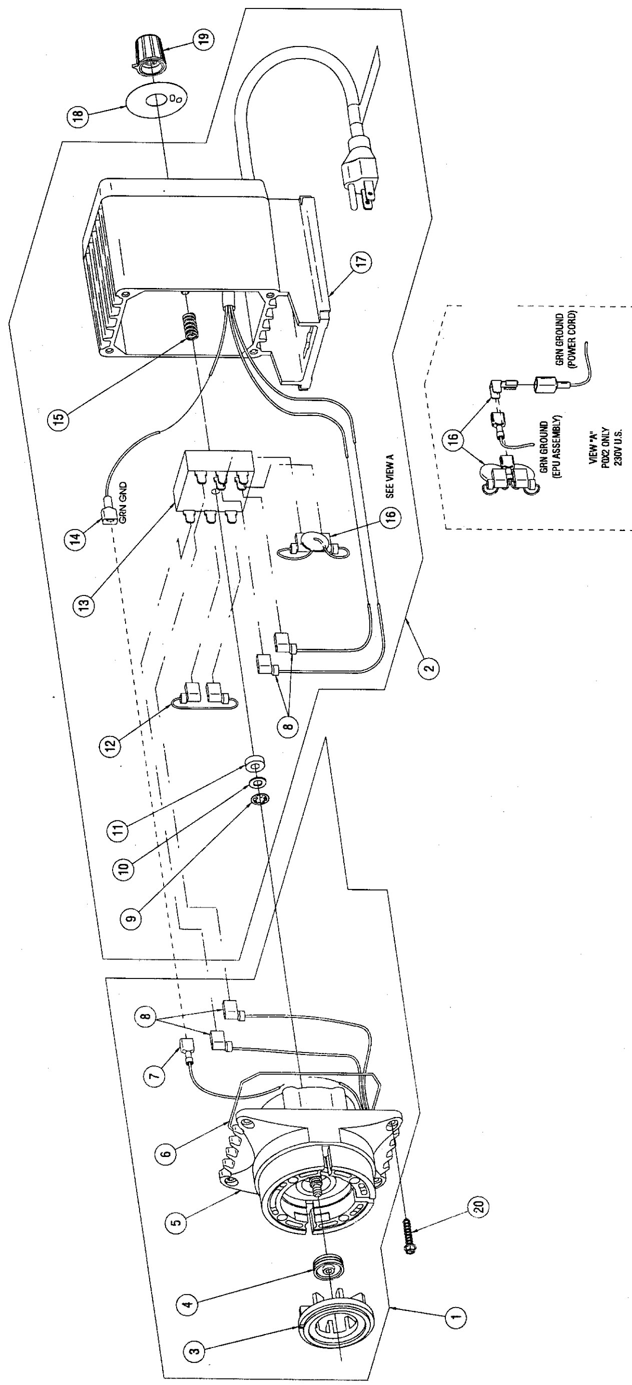
Series P0

Electronic Metering Pump



Metering Pump Component Diagram

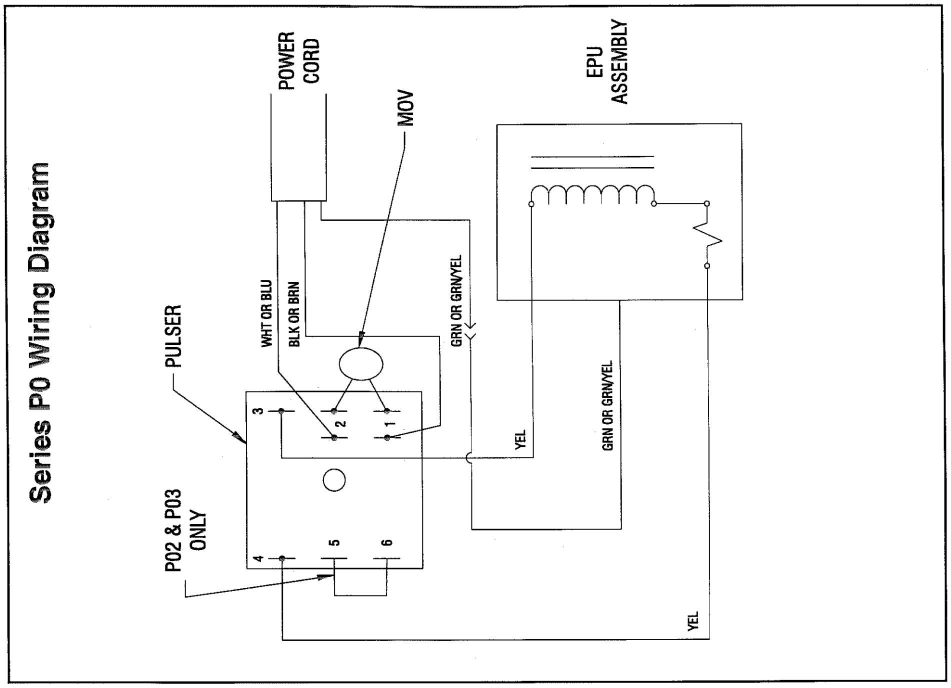
Series P0 Drive Assembly Exploded View Diagram

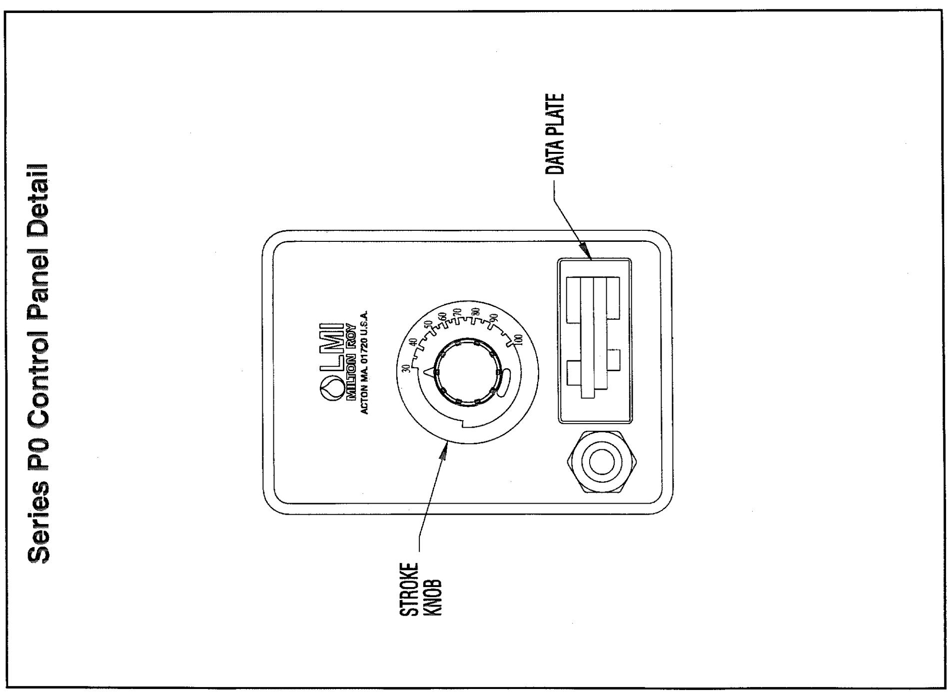


Series P0 Drive Assembly Parts List

Key No.	Model	Part No.	Description	Qty.
1	P021	30107	EPU w/Disk ,0.5	1
	P022, P023, P025, P026, P027	30108	EPU w/Disk ,0.5	1
	P031	30109	EPU w/Disk ,0.9	1
	P032, P033, P035, P036, P037	30110	EPU w/Disk, 0.9	1
	P041	30240	EPU w/Disk, 0.5	1
	P042, P043, P045, P046, P047	30241	EPU w/Disk, 0.5	1
	P051	30242	EPU w/Disk, 0.9	1
	P052, P053, P055, P056, P057	30243	EPU w/Disk, 0.9	1
	P061	33338	EPU w/Disk, 1.8	1
	P062, P063, P065, P066, P067	31781	EPU w/Disk, 1.8	1
2	P021, P031	36368	Housing Assembly w/Pulser, 115V	1
	P022, P032	36369	Housing Assembly w/Pulser, 230V US	1
	P023, P033	36370	Housing Assembly w/Pulser, 230V DIN	1
	P025, P035	36371	Housing Assembly w/Pulser, 240V UK	1
	P026, P036	36372	Housing Assembly w/Pulser, 250V AUST	1
	P027, P037	36373	Housing Assembly w/Pulser, 230V SWISS	1
	P041, P051, P061	36374	Housing Assembly w/Pulser, 115V	1
	P042, P052, P062	36375	Housing Assembly w/Pulser, 230V US	1
	P043, P053, P063	36376	Housing Assembly w/Pulser, 230V DIN	1
	P045, P055, P065	36377	Housing Assembly w/Pulser, 240V UK	1
	P046, P056, P066	36378	Housing Assembly w/Pulser, 250V AIST	1
	P047, P057, P067	36379	Housing Assembly w/Pulser, 230V SWISS	1
3	P02, P04	29445	Disk, 0.5	1
	P03, P05	29437	Disk, 0.9	1
	P06	29442	Disk, 1.8	1
4	P0	10973	Seal	1
5	P021, P031	30530	EPU	1
	P022, P023, P025, P026, P027 P032, P033, P035, P036, P037	30531	EPU	1
	P041, P051	30154	EPU	1
	P042, P043, P045, P046, P047 P052, P053, P055, P056, P057	30155	EPI	1
	P061	31862	EPU	1
	P062, P063, P065, P066, P067	31131	EPU	1

Key No.	Model	Part No.	Description	Qty
6	P0	10166	O-Ring	1
7	P0	10182-1	Wire Terminal (Female)	1
8	P0	25070-1	Wire Terminal (Flag)	4
9	P0	10422	Retaining Ring	1
10	P0	25963	Washer, Nylon	1
11	P0	30391	Washer, Rubber	1
12	P02,P03	29797	Wire Assembly	1
13	P0	36254	Pulser	1
14	P0	10368-1	Wire Terminal (Male)	1
15	P0	25414	Spring	1
16	P021, P031, P041, P051, P061	10626	Varistor Assembly, 115V	1
	P022, P032, P042, P052, P062	31255	Varistor Assembly, 230V US	1
	P023, P033, P043, P053, P063 P025, P035, P045, P055, P065 P026, P036, P046, P056, P066 P027, P037, P047, P057, P067	10627	Varistor Assembly, 230-250V	1
17	P021, P031, P041, P051, P061	36380	Housing Assembly, 115V	1
	P022, P032, P042, P052, P062	36381	Housing Assembly, 230V US	1
	P023, P033, P043, P053, P063	36382	Housing Assembly, 230V DIN	1
	P025, P035, P045, P055, P065	36383	Housing Assembly, 240V UK	1
	P026, P036, P046, P056, P066	36384	Housing Assembly, 250V AUST	1
	P027, P037, P047, P057, P067	36385	Housing Assembly, 230V SWISS	1
18	P02	30418	Stroke Dial	1
	P03	31545	Stroke Dial	1
	P04,P05	31126	Stroke Dial	1
	P06	31127	Stroke Dial	1
19	P0	30295	Stroke Knob	1
20	P0	30306	Screw	4


Series P0 Wiring Diagram
POWER CORD
MOV
EPU ASSEMBLY
PULSER
WHT OR BLU
BLK OR BRN
GRN OR GRN/YEL
YEL
GRN OR GRN/YEL
P02 & P03 ONLY
YEL

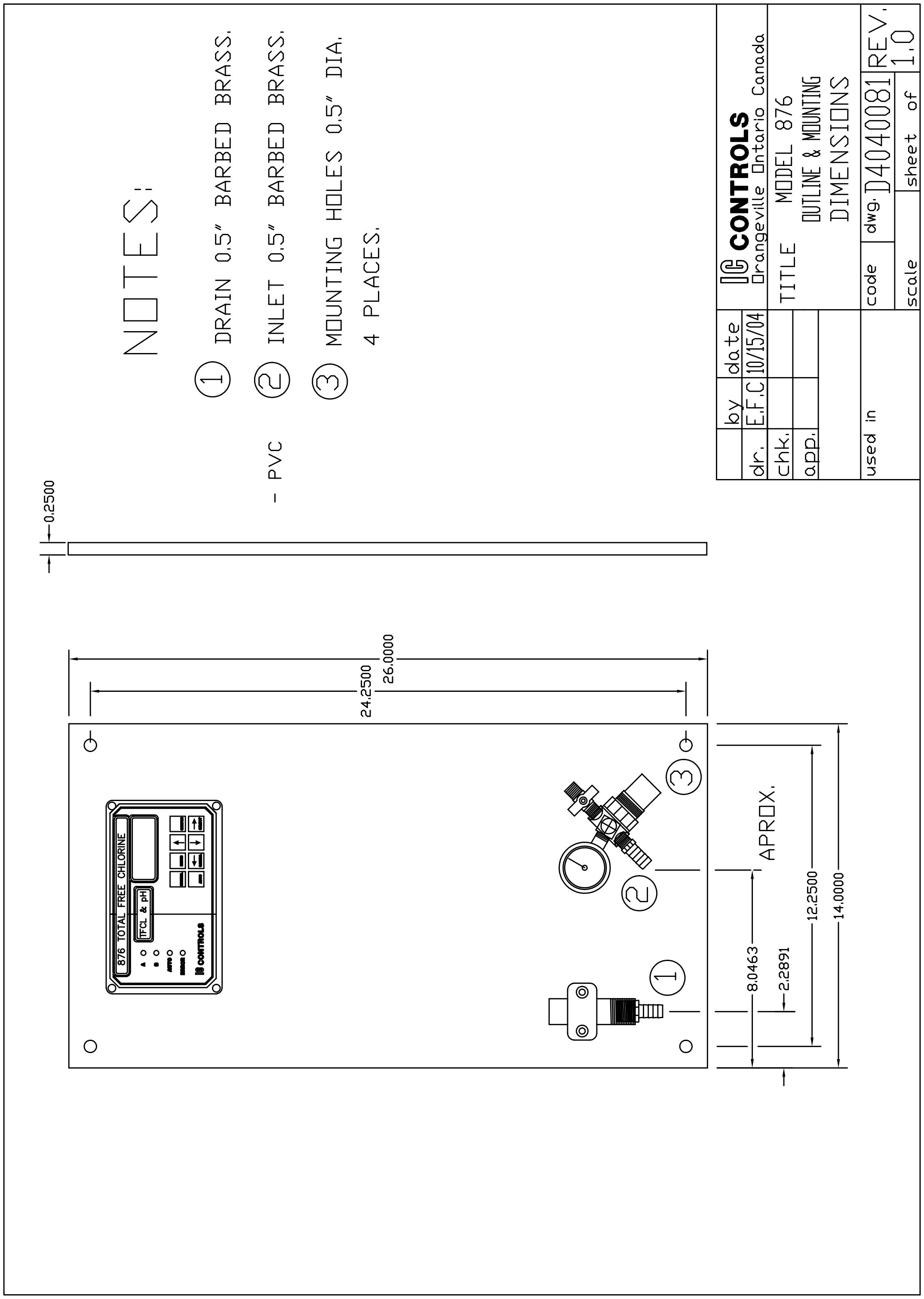

Series P0 Control Panel Detail
DATA PLATE
LMI MILTON ROY
ACTON MA. 01720 U.S.A.
STROKE KNOB

APPENDIX E – PARTS LIST

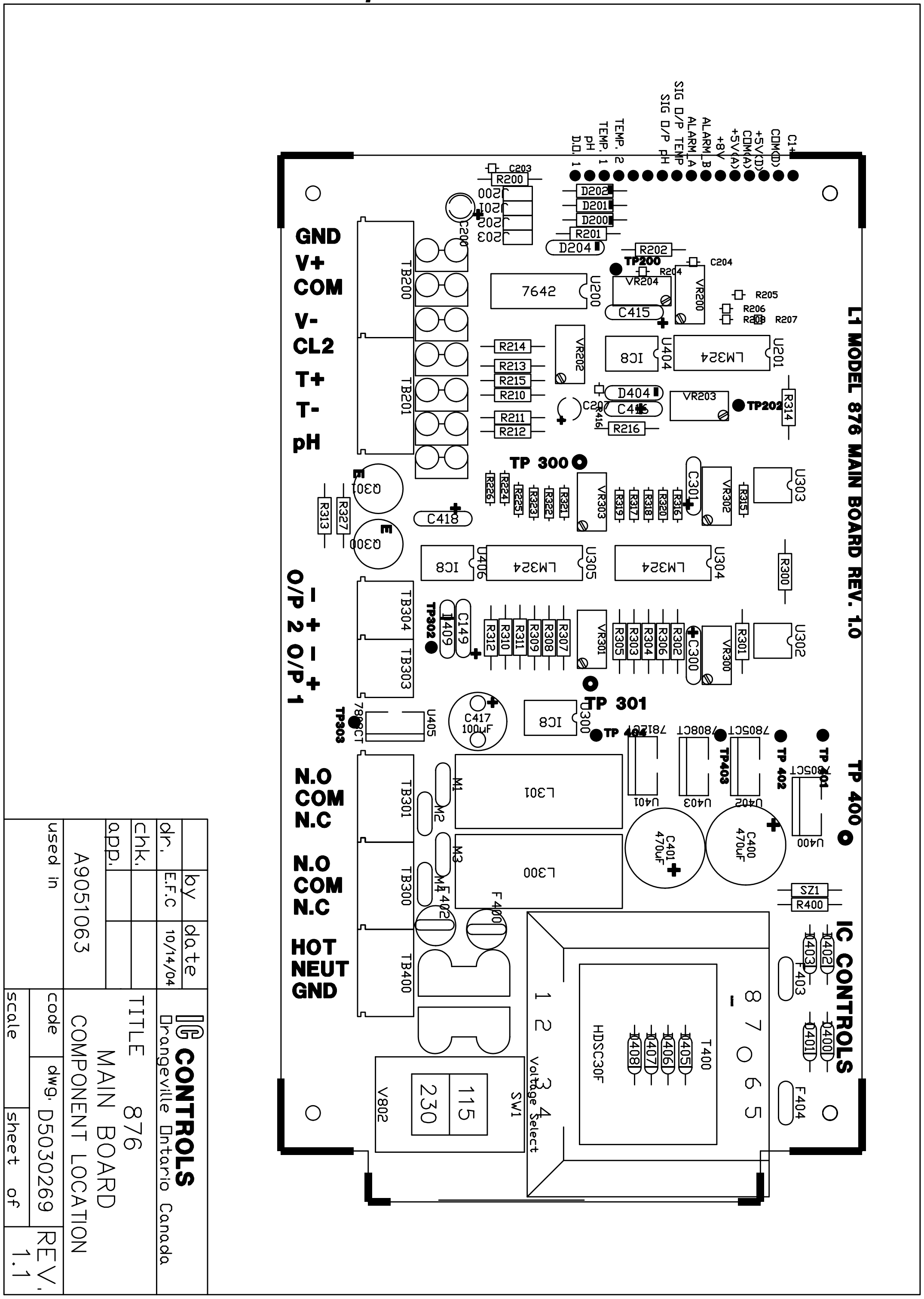
PART NUMBER	*DESCRIPTION*	*REFERENCE DRAWING NUMBER*
876-25 Free Available Chlorine Analyzer		
A2500033-6	pH preamp	D5040276
A9051009-OS	Assembly 876 Micro/display board	D5980176
A9051063	Assembly, 876 Main board	D5030269
A9141007	Assembly, M55 case complete	
A9201014	16-wire interconnector cable, two-end	
A9160024	0.25 A microfuse	
A9160029	0.10 A microfuse	
A9201046	5-pin adapter for chlorine sensor	
A2104023	876 dual sensor manifold	
A7300011	0 psi to 30 psi, ¼ inch NPT pressure regulator	
A7300013	0 psi to 100 psi, 2 inch pressure guage	
A7300014	Brass shut-off needle valve	
A2100082	115 VAC metering pump and accessories (for automatic cleaning option -51)	
A2100083	220 VAC metering pump and accessories (for automatic cleaning option -53)	
Chlorine Sensor		
A2104034	Chlorine sensor with TC	
A9201047	5-pin shorting plug for chlorine sensor	
pH Sensor		
A2104033	pH sensor, no TC	
Chlorine Consumables		
A7010001	Chlorine calibration kit	
A7010002	Chlorine calibration ampoules, qty 30; for A7010001	
A7010004	Precision, 0.001 ppm portable chlorine calibrator	
A7010005	Chlorine calibration ampoules, qty 30; for A7010004	
A2104035	Membrane replacement toolkit	
A2104036	Membranes; qty 5	
A1100239	Chlorine sensor fill solution, 100 mL	
A1100225	Zero chlorine solution, 500 mL	
A1100227	Chlorine renew solution, 30 mL	
pH Consumables		
A1100051	4 buffer, red, 500 mL (A1100051-6P for 6-pack)	
A1100052	7 buffer, green, 500 mL (A1100052-6P for 6-pack)	
A1100053	10 buffer, blue, 500 mL (A1100053-6P for 6-pack)	
A1100054	Buffer 6-pack; 4 pH, 7 pH, 10 pH	
A1100090	Electrode storage solution, 500 mL (A1100090-6P for 6-pack)	
A1100091	Electrode wash solution, 500 mL (A1100091-6P for 6-pack)	
A1100092	Deionized rinse water, 500 mL (A1100092-6P for 6-pack)	
A1100094	Gentle scale remover, 500 mL (A1100094-6P for 6-pack)	

DRAWINGS

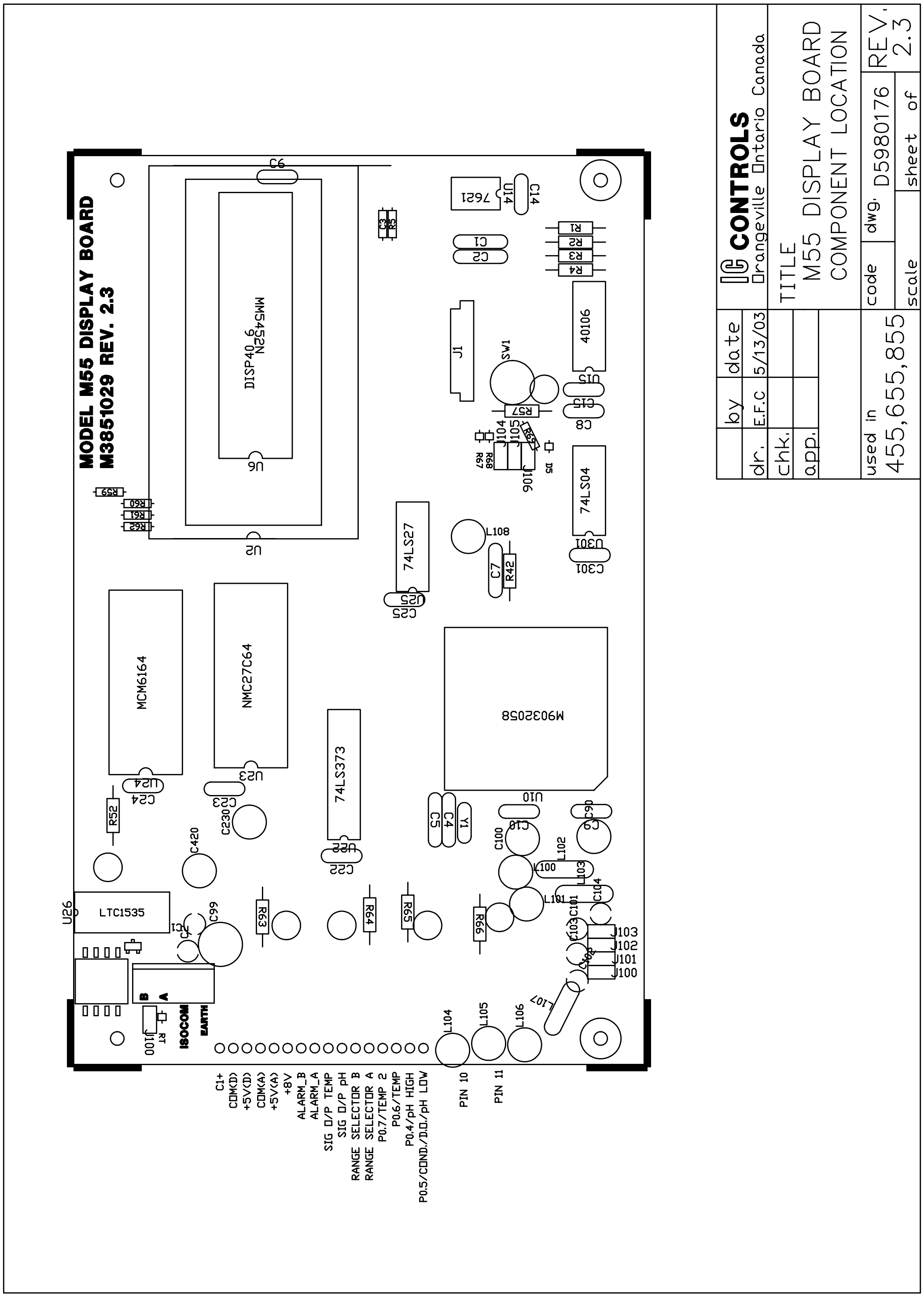
D4040081: Outline and Mounting Dimensions



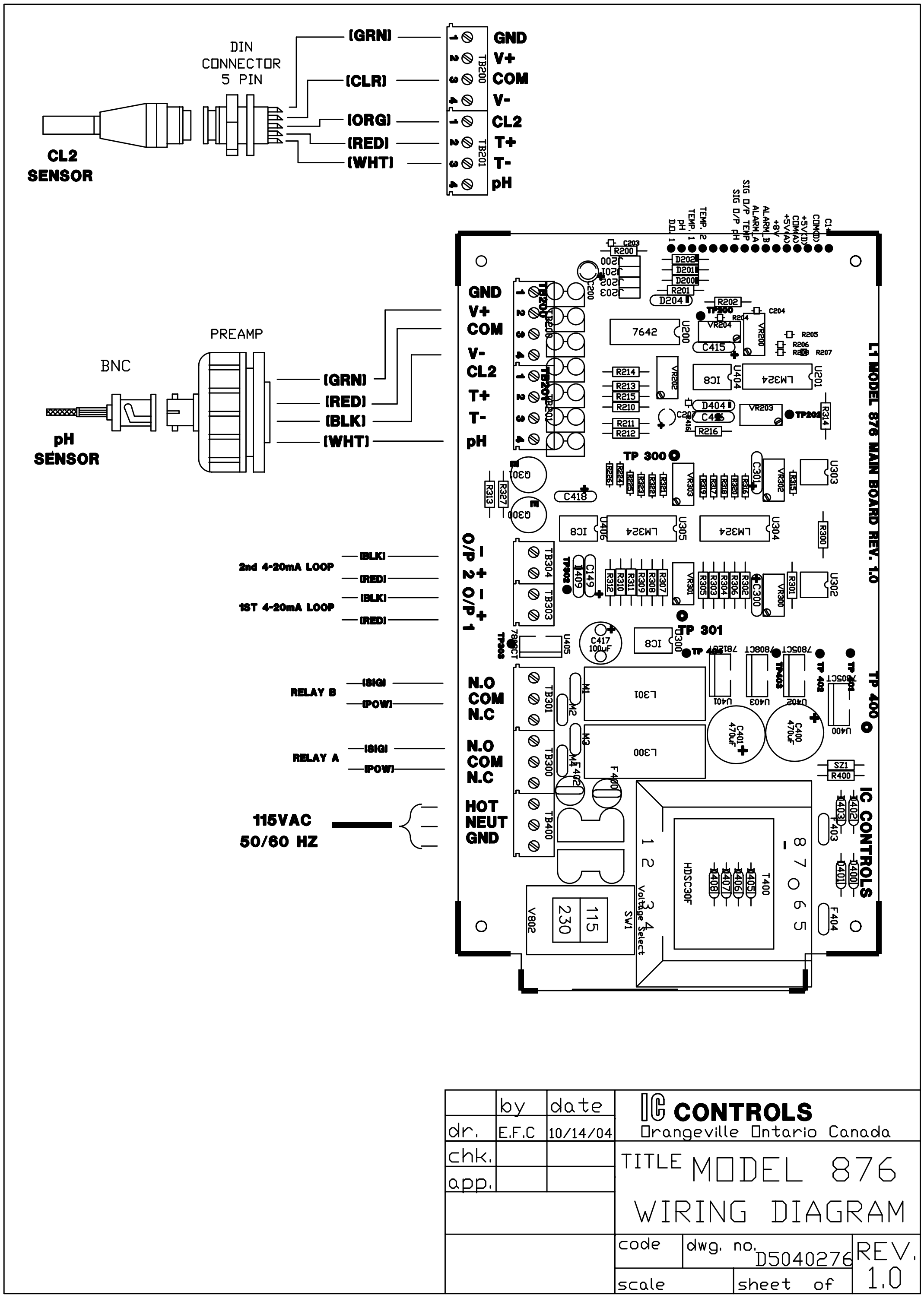
D5030269: Main Board Component Location



D5980176: Display Board Component Location



D5040276: Wiring Diagram



IC CONTROLS LTD. Head Office, Manufacturing & Research
29 Centennial Road, Orangeville, Ontario, L9W 1R1 Canada Tel: (519) 941-8161 Fax: (519) 941-8164

INDUSTRIAL PRODUCTS WARRANTY

Industrial instruments are warranted to be free from defects in material and workmanship for a period of twelve (12) months from the date of installation or eighteen (18) months from the date of shipment from IC CONTROLS whichever is earlier, when used under normal operating conditions and in accordance with the operating limitations and maintenance procedures in the instruction manual, and when not having been subjected to accident, alteration, misuse, or abuse. This warranty is also conditioned upon calibration and consumable items (electrodes and all solutions) being stored at temperatures between 5 °C and 45 °C (40 °F and 110 °F) in a non-corrosive atmosphere. IC CONTROLS consumables or approved reagents must be used or performance warranty is void. Accessories not manufactured by IC CONTROLS are subject to the manufacturer's warranty terms and conditions.

Limitations and exclusions:

Industrial electrodes, and replacement parts, are warranted to be free from defects in material and workmanship for a period of three (3) months from the date of installation or eighteen (18) months from the date of shipment when used under normal operating conditions and in accordance with the operating limitations and maintenance procedures given in the instruction manual and when not having been subjected to accident, alteration, misuse, abuse, freezing, scale coating, or poisoning ions.

Chemical solutions, standards or buffers carry an "out-of-box" warranty. Should they be unusable when first "out-of-box", contact IC CONTROLS immediately for replacement. To be considered for warranty, the product shall have an RA (Return Authorization) number issued by IC CONTROLS service department for identification and shall be shipped prepaid to IC CONTROLS at the above address.

In the event of failure within the warranty period, IC CONTROLS, or its authorized dealer will, at IC CONTROLS option, repair or replace the product non-conforming to the above warranty, or will refund the purchase price of the unit.

The warranty described above is exclusive and in lieu of all other warranties whether statutory, express or implied including, but not limited to, any implied warranty of merchantability or fitness for a particular purpose and all warranties arising from the course of dealing or usage of trade. The buyer's sole and exclusive remedy is for repair, or replacement of the non-conforming product or part thereof, or refund of the purchase price, but in no event shall IC CONTROLS (its contractors and suppliers of any tier) be liable to the buyer or any person for any special, indirect, incidental or consequential damages whether the claims are based in contract, in tort (including negligence) or otherwise with respect to or arising out of the product furnished hereunder.

Representations and warranties made by any person, including its authorized dealers, distributors, representatives, and employees of IC CONTROLS, which are inconsistent or in addition to the terms of this warranty shall not be binding upon IC CONTROLS unless in writing and signed by one of its officers.

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